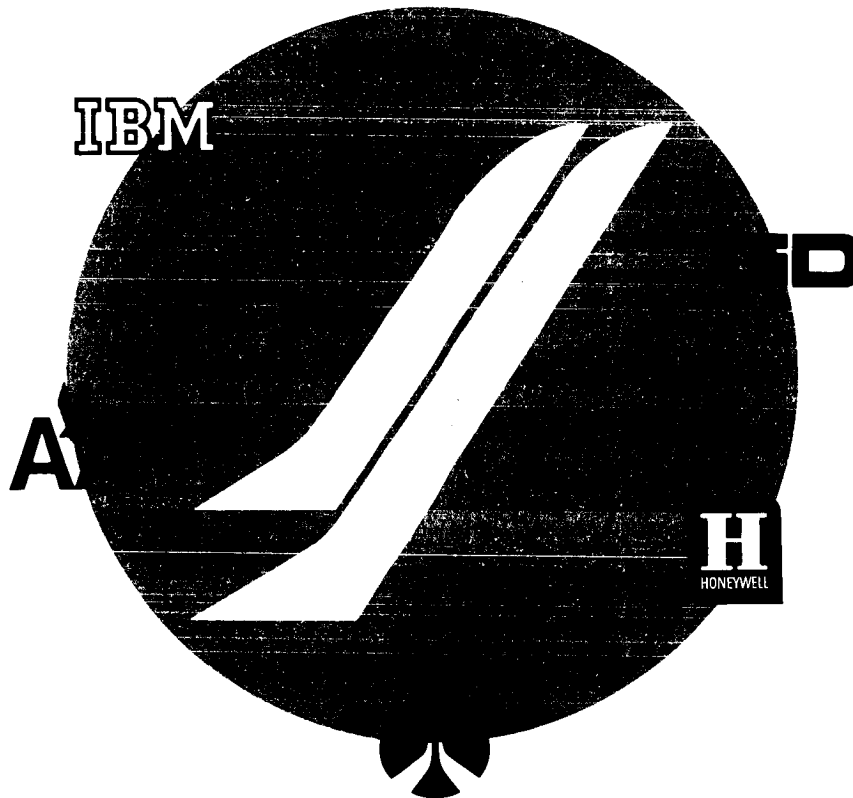


# Space Shuttle Program

CR 134297

MSC-03308

FINAL SUBMITTAL



(NASA-CR-134297) SPACE SHUTTLE PROGRAM  
MANAGEMENT PLAN FOR PHASE C/D Final  
Submittal (North American Rockwell Corp.)  
190 p

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## Program Management Plan for Phase C/D

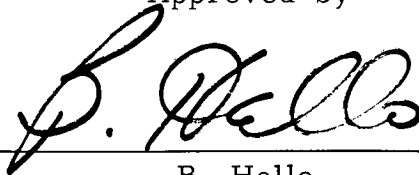
Contract NAS9-10960  
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SD 71-101  
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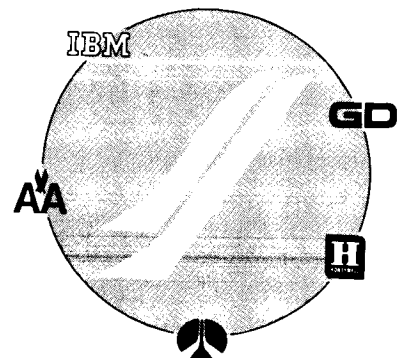
SPACE SHUTTLE  
PROGRAM MANAGEMENT PLAN  
for Phase C/D

Approved by



B. Hello  
Vice President and General Manager  
Space Shuttle Program

Contract NAS9-10960  
DRL M010, DRL Item 13  
DRD MA017M





## FOREWORD

This plan is one of a family of program plans that establish, as applicable, requirements and prospective implementation approaches for the conduct of Phase C (Design) and Phase D (Development and Operations) of the Space Shuttle Program. With the exception of the cost data, which appear in the Cost and Schedule Estimates Plan only, each plan has been prepared in accordance with the specific contract requirements described in the Contract NAS9-10960 Statement of Work, Paragraph 4.7 and Appendix A, Data Requirements. These plans are as follows:

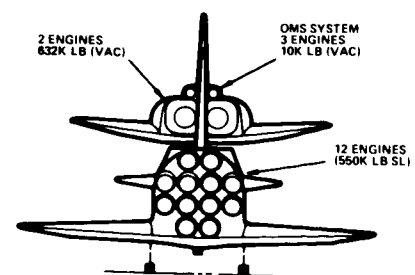
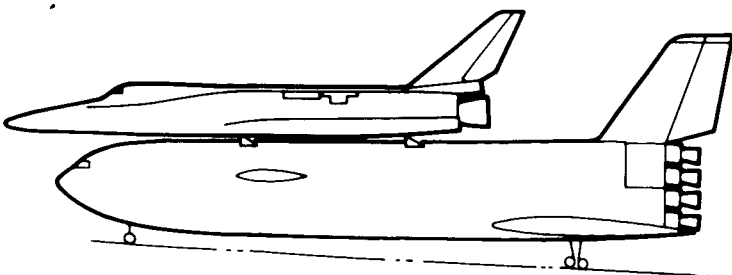
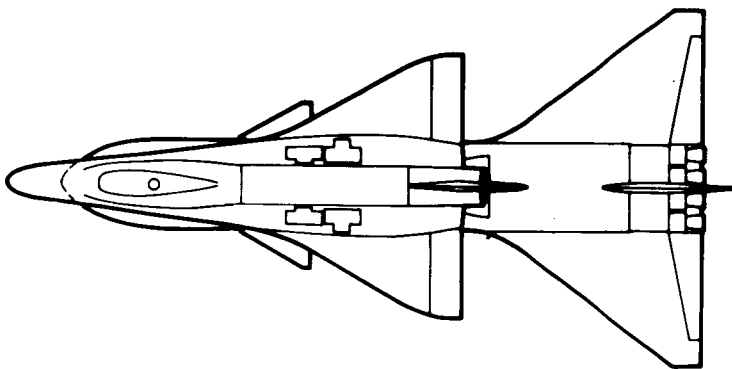
Title	Volume	SD No.	MSC No.
Program Management Plan for Phase C/D	One volume	SD 71-101	MSC-03308
Engineering and Development Plan for Phase C/D	I. Shuttle System II. Orbiter System III. Booster System	SD 71-102-1 SD 71-102-2 SD 71-102-3	MSC-03309
Operations Plan for Phase C/D	I. Shuttle System II. Orbiter III. Booster	SD 71-103-1 SD 71-103-2 SD 71-103-3	MSC-03310
Facility Utilization and Manufacturing Plan for Phase C/D	I. Orbiter II. Booster	SD 71-104-1 SD 71-104-2	MSC-03311
Preliminary Test Plan for Phase C/D	I. Shuttle System II. Orbiter III. Booster IV. Shuttle Support Equipment V. Shuttle Software	SD 71-105-1 SD 71-105-2 SD 71-105-3 SD 71-105-4 SD 71-105-5	MSC-03312
Logistics and Maintenance Plan for Phase C/D	One volume	SD 71-106	MSC-03313
Program Cost and Schedule Estimates Plan for Phase C/D	One volume	SD 71-107	MSC-03314



## PREFACE

The objective of the Space Shuttle Program is to provide a low-cost space transportation system for placing and retrieving payloads in earth orbit. The first manned orbital flight is scheduled for April 1978. To achieve this goal, a reusable space shuttle system capable of a rapid turnaround, airline-type ground operation has been defined, satisfying as a minimum three basic missions: (1) 100-nautical-mile due-east circular orbit originating from a latitude of 28.5 degrees north, (2) a 55-degree inclination, 270-nautical mile earth orbit, and (3) a 100-nautical mile south polar circular orbit.

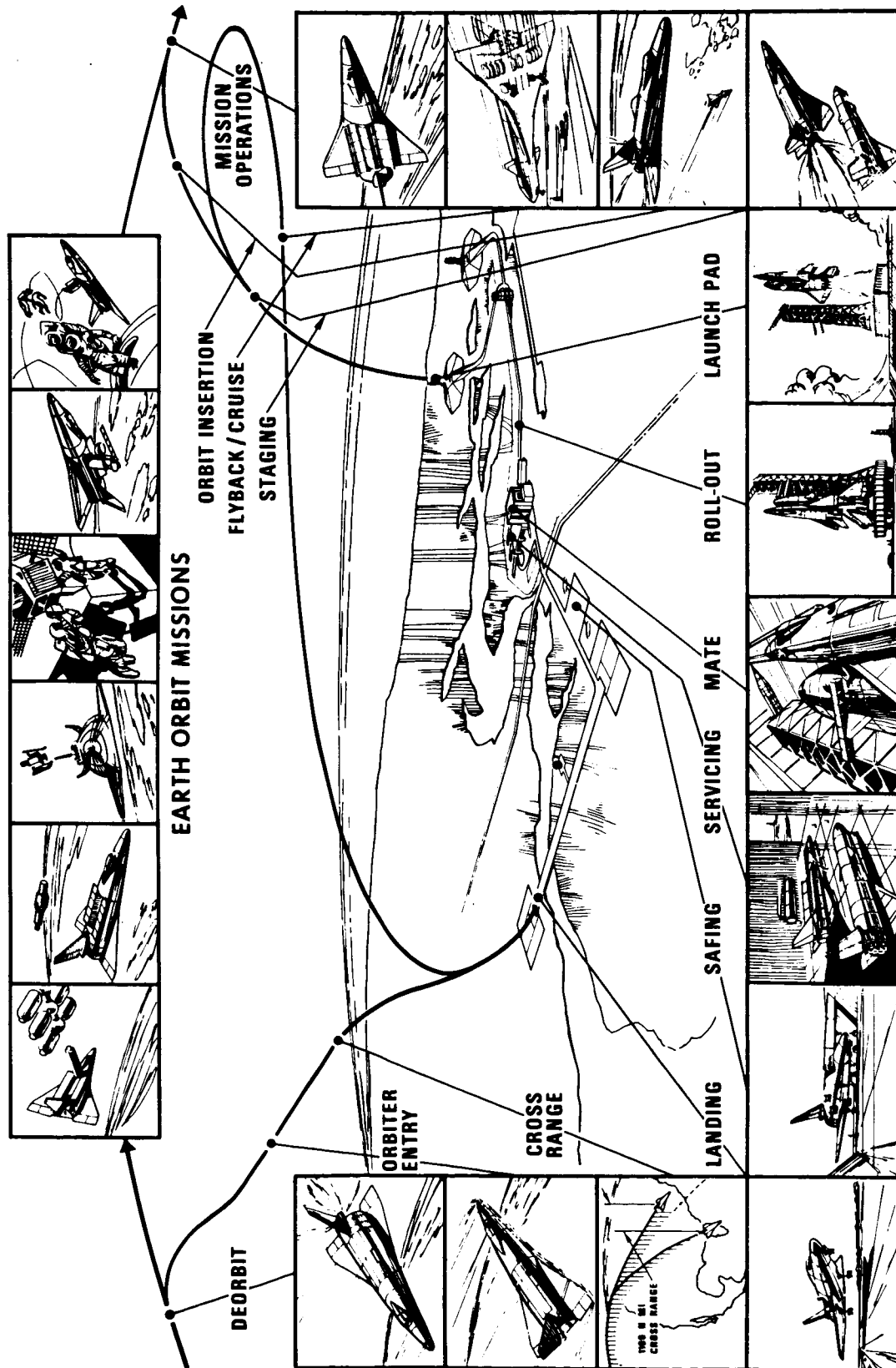
To accomplish these missions, a two-stage launch vehicle (shown below) has been defined, which is capable of delivering into orbit one stage with its payload. Each stage is capable of atmospheric entry and return to a designated landing site. The vehicle features moderate acceleration levels, a shirtsleeve cabin environment and quick turnaround capability. Operational facilities and system support equipment complement the flight vehicle.





The booster and the orbiter are reusable delta-wing vehicles. The booster is equipped with 12 main rocket engines, an external heat shield to withstand the temperatures of boost and suborbital entry, and deployable airbreathing engines for cruising back to the launch site. The orbiter is equipped with two main rocket engines, orbital maneuvering rocket engines, an external thermal protection system to withstand the temperatures of boost and orbital entry, and deployable air-breathing engines installed for specific missions. The operations facility will provide for preflight readiness checkout, payload installation, and launch control, as well as primary landing sites and facilities for vehicle turnaround and necessary servicing. Shuttle support equipment includes all equipment required to check out, service, handle, and launch the flight vehicles.

The significant elements of these missions, as shown in the following figure, are ground operations, launch, and staging of the two vehicles. After staging, the first stage (booster) returns to the launch area while the second stage (orbiter) attains the prescribed insertion orbit after a series of orbital maneuvers. The second stage (orbiter) then delivers or retrieves its payload, enters the atmosphere, acquires the landing site, and completes the approach and landing. Safing operations are completed on each vehicle at the landing area preparatory to the turnaround cycle ground operations. Subsequent to payload installation in the orbiter, the orbiter is mated with the booster, and the mated system is made operationally ready and transported to the launch area for a new mission.



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Elements of Space Shuttle Operations



## CONTENTS

Section	Page
1.0 INTRODUCTION . . . . .	1-1
2.0 PROGRAM ORGANIZATION . . . . .	2-1
3.0 PERFORMANCE MANAGEMENT . . . . .	3-1
3.1 PLANNING . . . . .	3-1
3.1.1 Work Breakdown Structure . . . . .	3-2
3.1.2 Establishing Planning Baselines . . . . .	3-2
3.1.3 Detail Work Planning . . . . .	3-7
3.2 WORK AUTHORIZATION SYSTEM . . . . .	3-12
3.3 ACCOUNTING AND STATUSING . . . . .	3-13
3.3.1 Accounting . . . . .	3-13
3.3.2 Status Analysis . . . . .	3-14
3.3.3 Management Displays . . . . .	3-16
3.4 CORRECTIVE ACTION . . . . .	3-16
3.5 CUSTOMER REPORTING . . . . .	3-17
3.6 PHASE C/D IMPLEMENTATION PLANS . . . . .	3-18
4.0 EXTERNAL INTERFACES AND RELATIONSHIPS . . . . .	4-1
4.1 SUBCONTRACT MANAGEMENT . . . . .	4-1
4.1.1 Pre-Subcontract Award . . . . .	4-1
4.1.2 Procurement Schedules . . . . .	4-2
4.1.3 Subcontractor Control . . . . .	4-2
4.1.4 NASA/Subcontractor Interfaces . . . . .	4-2
4.2 INTERDIVISION WORK MANAGEMENT . . . . .	4-3
4.3 NASA/CONTRACTOR INTERFACE . . . . .	4-3
4.3.1 Contractual Interfaces . . . . .	4-3
4.3.2 Program Technical and Management Information Interfaces . . . . .	4-4
4.3.3 NASA Responsibilities . . . . .	4-4
4.4 ASSOCIATE CONTRACTOR INTERFACE . . . . .	4-8
4.5 COMMONALITY MANAGEMENT . . . . .	4-8
4.5.1 General Requirements . . . . .	4-9
4.5.2 Development and Using Contractors . . . . .	4-9



Section	Page
5.0 ASSURANCE DISCIPLINES . . . . .	5-1
5.1 CONFIGURATION MANAGEMENT . . . . .	5-1
5.1.1 General . . . . .	5-1
5.1.2 Organization . . . . .	5-1
5.1.3 Configuration Identification . . . . .	5-2
5.1.4 Change Management . . . . .	5-6
5.1.5 Configuration Accounting . . . . .	5-7
5.1.6 Interface Management . . . . .	5-8
5.1.7 Subcontractor Configuration Management . . . . .	5-8
5.1.8 Configuration Management Reviews . . . . .	5-9
5.2 DATA MANAGEMENT . . . . .	5-9
5.2.1 Deliverable Data . . . . .	5-9
5.2.2 Government-Furnished Data . . . . .	5-10
5.3 MAINTAINABILITY MANAGEMENT . . . . .	5-10
5.4 RELIABILITY MANAGEMENT . . . . .	5-12
5.4.1 General . . . . .	5-12
5.4.2 Design Specification . . . . .	5-12
5.4.3 Reliability Evaluation . . . . .	5-13
5.4.4 Failure Mode Effects Analysis . . . . .	5-13
5.4.5 Maintainability . . . . .	5-13
5.4.6 Design Reviews . . . . .	5-13
5.4.7 Problem Reporting and Correction . . . . .	5-14
5.4.8 Parts and Materials Program . . . . .	5-14
5.4.9 Test . . . . .	5-15
5.5 QUALITY ASSURANCE MANAGEMENT . . . . .	5-15
5.5.1 Quality Assurance Management Organization . . . . .	5-15
5.5.2 Quality Assurance Procedures . . . . .	5-16
5.5.3 Quality Information . . . . .	5-16
5.5.4 Design Control . . . . .	5-16
5.5.5 Procurement Quality Controls . . . . .	5-16
5.5.6 Fabrication Quality Control . . . . .	5-16
5.5.7 Inspection and Test . . . . .	5-17
5.5.8 Nondestructive Evaluation . . . . .	5-17
5.5.9 Nonconformance Control . . . . .	5-17
5.5.10 Meteorology . . . . .	5-17
5.5.11 Stamp Control . . . . .	5-17
5.5.12 Handling and Storage . . . . .	5-18
5.5.13 Statistical Techniques . . . . .	5-18
5.5.14 Government Property Control . . . . .	5-18
5.6 SYSTEM SAFETY MANAGEMENT . . . . .	5-18



Section	Page
6.0	6-1
6.1	6-1
6.1.1	6-1
6.1.2	6-2
6.1.3	6-2
6.1.4	6-2
6.1.5	6-3
6.1.6	6-3
6.1.7	6-3
6.1.8	6-3
6.2	6-3
6.2.1	6-3
6.2.2	6-4
6.2.3	6-5
6.2.4	6-6
6.2.5	6-6
6.2.6	6-7
6.2.7	6-8
6.2.8	6-8
APPENDIX A. DEFINITIONS.	A-1
APPENDIX B. PLANNING DOCUMENTS	B-1
WORK BREAKDOWN STRUCTURE REQUIREMENTS	B-1
PROGRAM DEVELOPMENT LOGIC	
REQUIREMENTS.	B-2
PROGRAM SCHEDULE REQUIREMENTS	B-2
APPENDIX C. COMMONALITY CANDIDATES	C-1
APPENDIX D. RELIABILITY	D-1
APPENDIX E. QUALITY ASSURANCE	E-1
APPENDIX F. SYSTEM SAFETY	F-1



Section	Page
APPENDIX G. DEVELOPMENT APPROACH . . . . .	G-1
PROGRAM PLANS . . . . .	G-1
COST/SCHEDULE PLANNING AND CONTROL SYSTEMS . . . . .	G-2
PLANNING LEVELS . . . . .	G-2
ADVANCE PROBLEM WARNING . . . . .	G-2
DATA MANAGEMENT . . . . .	G-3
CONFIGURATION MANAGEMENT . . . . .	G-4
QUALITY ASSURANCE MANAGEMENT . . . . .	G-4

## ILLUSTRATIONS

Figure	Page
3-1	Baseline/WBS Relationship . . . . . 3-3
3-2	An Approach to Organization/WBS Relationship . . . . . 3-6
B-1	Phase C/D WBS . . . . . B-3
B-2	Space Shuttle System Development Logic . . . . . B-5
B-3	Space Shuttle Phase C/D Master Program Schedule . . . . . B-11



## 1.0 INTRODUCTION

The Program Management Plan defines the requirements for managing the Phase C/D Space Shuttle Program. Management systems are intended to provide to management personnel the information and visibility they need to effectively meet program requirements.

Experienced managers formulated the system requirements contained herein. These managers have recommended a reasonable depth of routine application of these requirements to avoid burdensome detail.

Accordingly, the result is a set of practical requirements tailored to the Space Shuttle Program. These requirements permit potential contractors to apply systems best suited to their own organizations, personnel, and experience.

The essential activities for properly managing a program are to establish a performing organization, to provide work assignments to personnel within the organization, and to measure and control the effectiveness by which the work assignments are carried out. The plan has been structured to logically sequence and identify the requirements for fulfilling the essential program management activities.

The program organization requirements are covered first, followed by control of program cost, schedule, and technical performance. Next are subjects dealing with management of interfaces between the contractor and outside organizations. After that a series of special management activities is covered. A section on integration management concludes the plan. Discussed in Appendix G are results of analysis and studies to identify improvements in management practices.



## 2.0 PROGRAM ORGANIZATION

The program organization must provide the means for effectively planning and controlling the total program to fulfill contract requirements. Requirements to be met in establishing this organization are:

1. Provide a full-time program manager with full authority for implementation of the program.
2. Establish a program organization with defined organizational elements to cover all functions required for program implementation.
3. Define authority, responsibility, and accountability of each organizational element.
4. Establish formal communications means among organizational elements.
5. Provide the capability to assess product-oriented cost, schedule, and technical status across functional lines.
6. Provide the means for resolving problems across functional organization lines.
7. Provide customer and associate contractor contacts within the program organization with authority for reporting, negotiating, and resolving specific issues related to program products.

Covered in the remainder of this plan are requirements for management systems and processes for use by the program organization in fulfilling its basic functions.



### 3.0 PERFORMANCE MANAGEMENT

The performance management system provides the program manager with formal procedures to plan the program, authorize the work, and determine program status. The result is to use the system to control costs, to adhere to schedules, and to assure proper technical achievement. The system is carried out within the framework of a negotiated contract that establishes targets for costs, schedules, and technical goals. The overall requirements for the performance management system are:

1. Establish and maintain time-phased records of negotiated contract value.
2. Establish and maintain records of negotiated contract milestones.
3. Establish and maintain records of technical-performance measurement parameters selected from the technical specifications.
4. Periodically compare cost, schedule, and technical performance to plans.
5. Isolate factors causing deviations from plans.
6. Project cost and schedule estimates for contract completion.

The succeeding subsections cover the particulars of the system requirements. Definitions of terms used in this section are in Appendix A.

#### 3.1 PLANNING

Planning of the total program provides contractor and NASA program management with a top-level layout of the program from initiation of Phase C through completion of Phase D. This planning is used as a basis for weighing the effects of current operations and deciding on the conduct and course of the program. Firm detailed planning, required for actual implementation of work, is developed progressively by successively lower levels of management. Planning involves the planning sub-elements discussed in the paragraphs that follow.



### 3.1.1 Work Breakdown Structure

The work breakdown structure (WBS) is a product-oriented division of the program into lower-level, manageable segments of work. Appendix B contains the Phase C/D space shuttle WBS. The WBS is used as a common framework for program planning and for managing program costs, schedules, and technical performance.

The requirements for the WBS are:

1. The contractor shall establish and maintain a contract WBS based on a top-level WBS supplied by NASA.
2. The WBS shall cover that work required by the contract.
3. The WBS shall be extended to at least the subsystem level (level 5) and to lower levels where appropriate.
4. Changes to the WBS shall be formally controlled.
5. A dictionary-type definition describing the work of each WBS element shall be maintained.

### 3.1.2 Establishing Planning Baselines

Performance management activities are conducted within the framework of the WBS. It is therefore necessary to relate these activities to the WBS. Respective levels of the WBS are selected as the level at which specific performance management activities take place. These selected levels are referred to as planning baselines. These baselines are depicted in Figure 3-1 and summarized as follows:

Contract baseline - The WBS level at which the contractor establishes and maintains records of the negotiated costs, milestones, and selected performance measurement parameters.

Reporting baseline - The level at which performance is reported to NASA.

Performance Baselines - The lowest WBS level at which organizational responsibilities for performance are assigned.

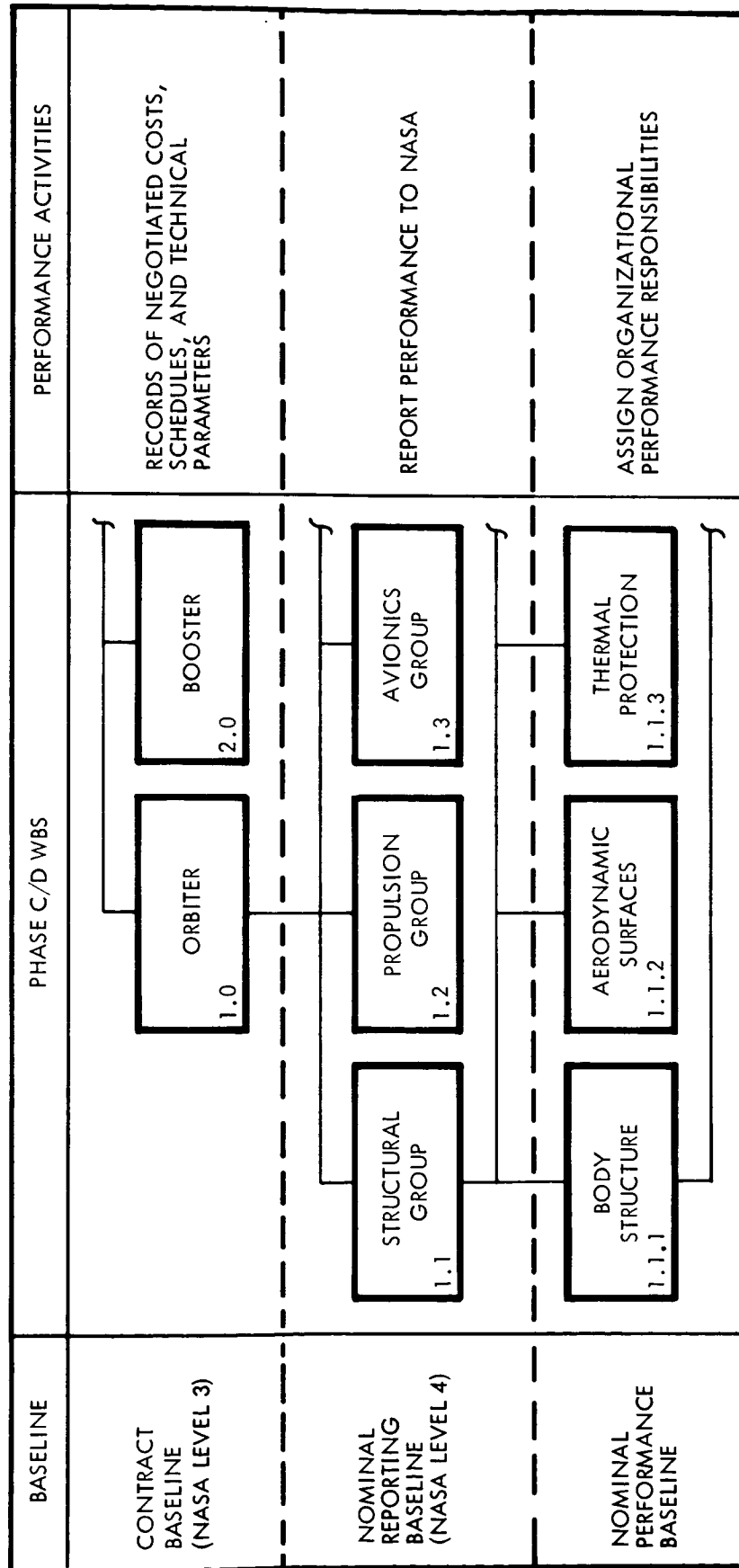


Figure 3-1. Baseline/WBS Relationships





The following subsections describe the planning activities that are required at each of the various baselines.

#### Contract Baseline Planning

1. Contract baseline planning shall reflect formal contractual requirements.
2. The planning shall reflect contractually authorized changes in a timely manner.
3. A schedule baseline shall be maintained and will typically contain contract end item delivery schedules and other major milestones that represent overall program constraint events or major control events.
4. A cost baseline shall consist of a single dollar amount for each contract line item representing the negotiated contract value.
5. The cost baseline for each line item shall be spread by government fiscal year for the planned duration of the contract.
6. A technical performance measurement baseline shall be maintained and will consist of a record and identification of those technical parameters used for formal technical performance measurement.
7. Contract baseline planning shall be conducted selectively but shall normally be done at Level 3 of the WBS (i. e. , orbiter, booster, etc. ).

#### Reporting Baseline Planning

1. The reporting baseline shall be established at those levels of the WBS at which the NASA Program Office will control the program. The level will be established selectively within the contract but will normally be at NASA Level 4 (subsystem group).
2. Detail planning shall be summarized to the reporting level to provide a yardstick for measuring performance.
3. Planning shall be by both the functional organization (Engineering, Manufacturing, etc. ) and by WBS element to measure functional progress as well as product progress.



## Performance Baseline Planning

1. Budgets shall be assigned at the performance baseline level for each functional organization. The performance baseline is subdivided into functional activities through the use of cost accounts.
2. The program manager shall clearly delineate the subdelegation of responsibility for budget and schedule allocation and control, status reporting, and baseline definition within the program organization down to the cost account level.
3. Planning to the cost account level shall exist for that period into the future required for further detailed planning. Beyond this period, planning may be grouped into packages of cost accounts provided each such package applies to work within one functional organization and one WBS element.
4. Individuals responsible for measuring performance at the cost account level shall be identified. These individuals are referred to as cost account managers.
5. The contractor shall maintain work packages comprising budgets, schedules, and technical performance milestones. These work packages represent the detail budget assignments that support the cost accounts.
6. Planning at the performance baseline shall be completed for at least the remainder of the current fiscal year when firm funding targets have been supplied by NASA.
7. For the succeeding fiscal year, and during any period when funding targets have not been established, performance-baseline-level planning shall be performed for approximately six months ahead.

## Relationship Between Functional Organizations and Products

Management of a program is carried out by the program manager through a program organization. Program products are a result of the activities of various functions within the program organization. It is therefore necessary as a part of the program management process to measure performance of functions as well as performance related to products. The combined use of WBS task element managers, cost accounts, and work packages provides the means by which functions can be managed and performance against products can be measured.

Figure 3-2 depicts an approach to a relationship between products and functional organizations. The relationship principal can apply to varying organizational and WBS concepts. The following requirements shall be met:

1. The contractor shall ensure that appropriate responsibility and reporting levels exist below the cost account level.

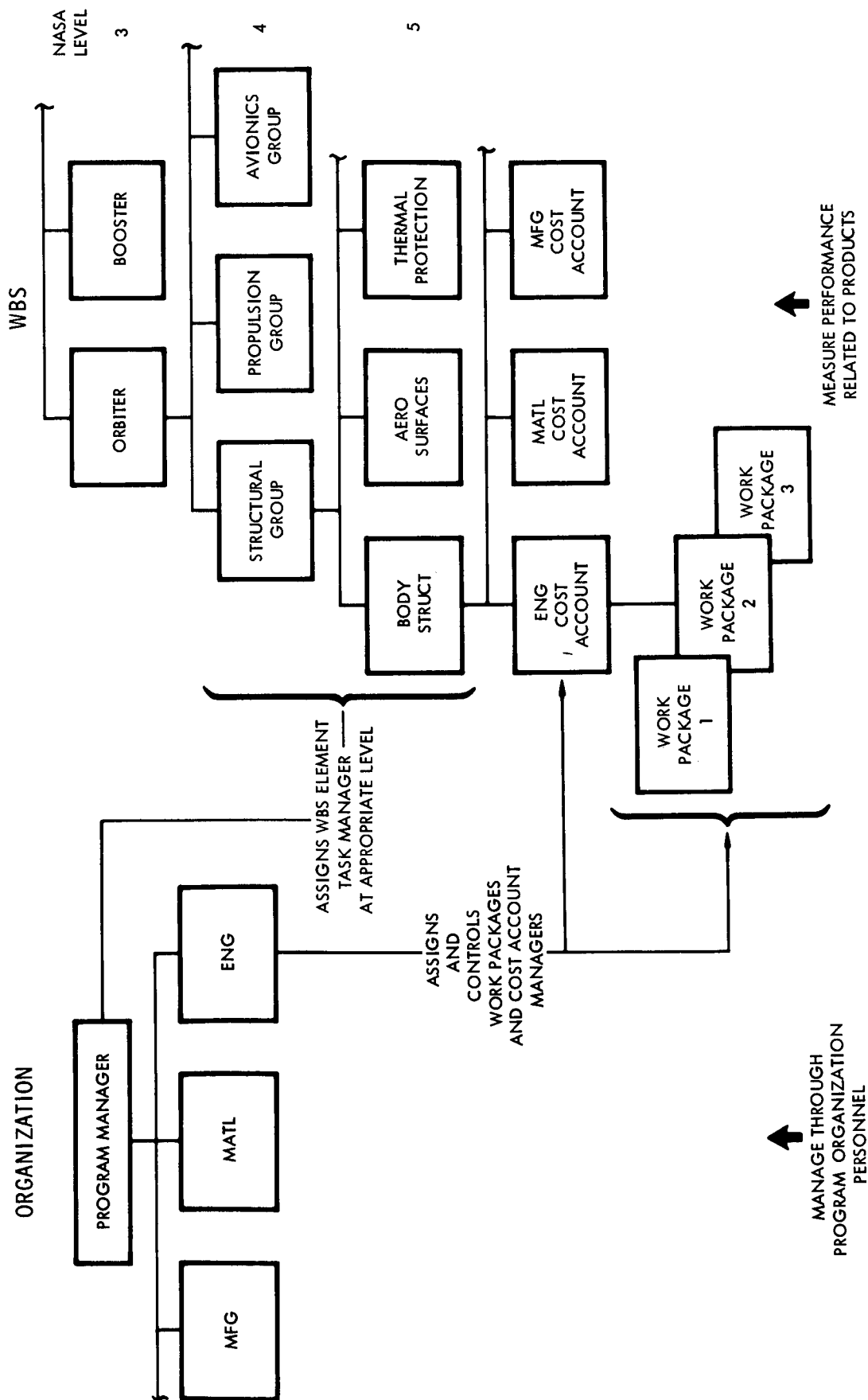


Figure 3-2. An Approach to Organization/WBS Relationship



2. The program manager shall establish appropriate subdelegation of authority to measure the performance-related program products. Individuals so assigned will monitor the progress against work packages for all functions. These individuals are referred to as WBS element task managers.
3. WBS element task managers shall be authorized to make direct contacts with the customer and associate contractors concerning their assigned task elements.

### 3.1.3 Detail Work Planning

Detail work planning depends on the availability of systems that properly identify program logic, schedules, costs, and technical parameters. In turn, work packages are formulated by using the information from these systems. In this section, the basic systems requirements are covered first, followed by the requirements for content, frequency, and traceability of work packages.

#### Program Logic Planning

The program logic defines the essential and logical order of primary phases, activities, and events required to accomplish the program. It is used to ensure that event and activity schedules are consistent with the necessary chronological ordering and interconstraining effects. Figure B-2 in Appendix B depicts a preliminary development logic for the Space Shuttle Program.

The program planning logic shall:

1. Be developed at the total program summary level and at selected supporting levels.
2. Define the interrelationships of major program products and objectives.
3. Be compatible with the WBS.
4. Be developed to a level of detail necessary to identify high risk areas in all phases of the contractor's program.
5. Define program constraints and control milestones appropriate to all levels of schedules and plans.



6. Be periodically updated to validate schedules, to define impact of problems, and to develop solution alternatives.
7. Be constructed in a manner that will facilitate their use in determining the impact of actual or proposed program changes.

### Program Schedule Planning

Schedule planning time-oriens the program work represented on the WBS in consonance with the order and constraints shown by the program logic. Schedules are used to establish the right timing and ordering of tasks to be performed and are used as a basis for measuring schedule performance. Schedule planning shall conform to the following requirements:

1. The contractor shall prepare a master program schedule (MPS) for Phases C and D of the Space Shuttle Program using the schedule depicted in Figure B-3 of Appendix B as a baseline.
2. The MPS shall be used as a basis to establish the negotiated contract schedule baseline.
3. The MPS shall be made available for formal NASA review concurrent with preliminary design review (PDR) or upon final contract negotiation, whichever occurs first.
4. The MPS shall be consistent with, and related to, the WBS and will identify contract milestones and significant program summary milestones.
5. The contractor shall establish and maintain a schedule control system that ensures compatibility between the MPS and lower-level-detail schedules.
6. The schedule control system shall further ensure that authorized program changes are promptly incorporated in the MPS and baseline schedules.
7. WBS element schedules shall be correlated to reporting level schedules
8. Major functional organization milestones within cost accounts and their correlation to supported WBS element schedules shall be identified.



9. Scheduled events or indicators of planned volume of work versus time shall be identified in a manner to provide objectively measurable work progress for the reporting period.
10. Relationship between work volume measurement milestones or indicators and cost account milestones shall be identified. This identification shall be contained in the work package documentation.

### Cost Planning

Cost planning divides and time-phases the total contract value by elements of cost, by function, and by products. Actual expenditures are compared against the planning "cuts" for monitoring of cost performance and accurate location of the cause of significant variances. In developing cost planning data, the contractor shall:

1. Prepare and maintain a total program financial plan in consonance with the negotiated contract.
2. Time-phase the financial plan by quarter for the ensuing four quarters and thereafter by government fiscal year.
3. Subdivide the financial plan by element of cost.
4. Assure that the financial plan contains direct budget allocations by function, i. e., Engineering, Manufacturing, Logistics, Test, Quality, etc.
5. Maintain the plan for the duration of the contract by incorporating authorized contract changes.
6. For the performance baseline planning period, establish budgets for all contractually authorized work to the cost account level with separate identification of cost elements (labor, material, etc.).
7. Identify level of effort in cost accounts which are planned and controlled by time-phased budgets established for this purpose. Only that effort which cannot be identified as discrete work packages or as apportioned effort will be classed as level of effort.
8. Identify undistributed budget consisting of internally unauthorized (future) work package budgets and level-of-effort budgets within cost accounts.



9. Provide that the sum of all work-package-level budgets within a cost account equals the cost account budget.
10. Summarize direct budgets from cost accounts into the WBS without allocation of a single cost account to two or more WBS elements.
11. Summarize direct budgets from the cost accounts into the contractor's functional organizational structure without allocation of a single cost account to two or more organizational elements.
12. Identify the methodology for establishing the budgets for apportioned effort.
13. Identify the indirect budgets and method for allocation to the contract.

### Technical Performance Measurement Planning

Technical performance measurement (TPM) provides management a tool for assessing technical performance and for early identification of technical problems and resulting cost and schedule impacts to the program. The requirements for technical performance measurement planning are:

1. Technical performance planning at the reporting baseline level shall be effected through the contractor's technical performance measurement system.
2. The contractor shall plan and implement a technical performance measurement system as an integral part of his technical management process.
3. The contractor shall initiate his TPM system at contract go-ahead and will be prepared to demonstrate its operation within a reasonable time thereafter.
4. System performance parameters shall be selected from Section 3.0 of the applicable end item specification.
5. TPM plans shall be prepared for selected parameters. These plans shall identify and define specific verification events that will permit the assessment of progress against the selected parameters.
6. Verification events shall reflect the verification methods listed in the specification, Section 4.0, which correspond to the selected performance parameters.



7. Selected performance parameters shall be related to the program WBS, and verification milestones shall be identified within subordinate schedules.
8. Technical performance values shall be measured at the planned level at the planned frequency, and results shall be submitted to higher levels of contractor engineering and program management.

#### Work Package Planning

Work package planning provides detailed working level instructions that will divide all work to be performed in a manner, sequence, and chronology to support the higher levels of contract planning. Work package planning requirements are:

1. All near-term contractual effort shall be planned, budgeted, and controlled at the work-package level.
2. Planning that exists at the cost account level shall be planned in more detail as the contract work is defined in greater depth.
3. Detail planning at the work package level shall be performed for as long a period into the future as is practical.
4. The work package shall contain budgets and schedules that constitute the plan against which the work package manager assesses and controls the working level tasks.
5. When all work packages within a cost account have been planned, the sum of their assigned budgets shall not exceed the total cost account budget.

#### Work Package Criteria

A work package shall meet the following criteria:

1. It represents a unit of work at the level where work is physically performed.



2. Its work content is clearly distinguished from all other work packages within the parent cost account.
3. It is assignable to a single cost account and organization element.
4. It has clear start and completion dates representative of physical accomplishment.
5. It has a budget expressed in terms of dollars, man-hours, or other measurable units.
6. Size and duration of work packages shall be such as to limit the total number of work packages to a manageable quantity.
7. It shall normally not be longer than one year nor less than three months in duration.
8. It shall have internal indicators to measure objectively the volume of work accomplished relative to the total work content of the work package.

#### Work Package Traceability

Traceability from the work package to the contract baseline is required to ensure that planning is in conformance with the tasks defined by the contract statement of work and the WBS dictionary. The requirements for work package traceability are:

1. Provide that each successive level of planning is derived from, and reconcilable to, its immediately preceding level.
2. Provide that all immediately succeeding levels of planning are identified at each planning level.
3. Provide that effects on planning of contract changes are reflected in the relevant elements at all planning levels and are incorporated in a timely manner.

#### 3.2 WORK AUTHORIZATION SYSTEM

The work authorization system provides the means by which management can ensure that appropriate resources have been allocated for work to be performed and that all work has been contractually authorized and



properly planned before it actually begins. The contractor's work authorization system shall conform to the following requirements:

1. Provide that the work to be done and the organizational elements responsible have been defined and identified before work is authorized to begin.
2. Assure that schedules, budgets, and technical performance requirements established for the work to be authorized are in consonance with the contract baseline.
3. Provide documented authorization for commencement of work, including traceability to the contract baseline.
4. Assure that work packages that have been closed shall not be reopened. For any changes in opened or unopened work packages there shall be a recorded explanation of budget and effort moved.

### 3.3 ACCOUNTING AND STATUSING

#### 3.3.1 Accounting

The contractor's accounting system shall provide for accurately recording all direct and indirect costs applicable to the contract. Such costs must be directly summarized from the level at which they are applied to the contract level. The contractor's accounting system shall meet the following requirements:

1. Record applied direct costs on a basis consistent with the budgets in a formal system that is controlled by the general books of account. Include within the book accounts the amounts charged to work completed and in process during the reporting period:
  - a. When labor, material, and other direct resources are actually consumed
  - b. When material resources are withdrawn from inventory for use
  - c. When material or subcontract software and other non-recurring resources are received that are uniquely identified to the contract
  - d. When major components or assemblies are received on a line flow basis that are specifically and uniquely identified to a single serially numbered end item



2. If an inventory carrier cost account is used for major material items as necessary to provide visibility into resources committed, transfer these inventory resources to cost accounts at point of usage.
3. Charge to that task or item of a program for which it was used material or component items used for test, spares, etc., or dispositioned as scrap, unanticipated test quantities, etc., Do not arbitrarily cost them to contract end items nor spread them over an indirect base.
4. Account for at point of usage government-furnished materials, as appropriate.
5. Accumulate costs in a manner that will identify recurring unit and equivalent unit costs and/or lot costs.
6. Summarize applied direct costs from the cost account through the WBS without allocation of a single cost account to two or more WBS elements.
7. Summarize applied direct costs from the cost account through the contractor's functional organization structure without allocation of a single cost account to two or more organizational elements.
8. Assure that the cost accumulation procedure enables the collection of all direct cost by cost element from cost account level, provides for direct summarization of cost through the organizational and WBS structure from the cost account level, and provides for the summarization of indirect cost to the total contract level.
9. Prohibit retroactive changes to records pertaining to work performed that will change previously reported amounts for applied direct costs or indirect costs, except for corrections of errors and routine accounting adjustments.

### 3.3.2 Status Analysis

Comparisons of planned value of work accomplished (PVWA) and planned value of work scheduled (PVWS) relate work completed to work scheduled during a given period. Comparisons of PVWA and actual costs will show whether completed work has cost more or less than was planned and originally budgeted. Analyses of these differences should reveal the factors contributing to the variances such as initial estimate for the task, technical factors requiring different application of resources, the cost of labor or materials different than planned, personnel efficiency different than planned, or a combination of such reasons.



In order that the above data are properly derived, the contractor's status analysis system shall:

1. Identify at the cost account level on a monthly basis using data from, or reconcilable with, the accounting system:
  - a. Planned value of work scheduled and planned value of work accomplished
  - b. Planned value of work accomplished and applied direct cost for the same work
  - c. Variances resulting from the aforementioned comparisons classified in terms of labor, material, or other appropriate elements together with the reasons for significant variances
2. Identify on a monthly basis total planned and actual indirect costs allocated to the contract at the total program level.
3. Summarize performance data at the total program and reporting level and determine variances from the performance baseline. Identify on a monthly basis significant differences between planned and actual schedule accomplishment and planned and actual technical performance, together with the reasons for the variation.
4. Analyze technical performance measurements and projected system performance values. Alternate possible corrective action shall be identified where necessary, and the most suitable course of action shall be selected, considering total program effects.
5. Identify managerial actions to be taken as a result of the aforementioned requirements.
6. Based on performance to date and on estimates of future requirements, develop at quarterly intervals revised estimates of cost at completion for WBS elements at the contract baseline and compare these with the fiscal-year budgets, the negotiated contract price, and the latest statement-of-funds requirements reported to the government.



### 3.3.3 Management Displays

The contractor shall establish and maintain a management data display system for contractor and NASA use. The following are required:

1. A management information center (MIC) that will be a management tool for contractor and NASA management use for status reviews, briefings, and coordination meetings.
2. Display in the MIC of current information on progress and control of the program for each area of management interest for all phases of the program.
3. Displays of basic control data in the form of planned performance baselines, status against the baseline, and action taken to correct deviations.
4. Identification of data displays to facilitate maintenance of equivalent data displays used by NASA at the NASA management information center.
5. Rapid and accurate changes to contractor data displays to reflect the current situation.
6. A method for communicating data that will permit near simultaneous update of the data displays at the NASA control center to coincide with changes made to the contractor displays.

### 3.4 CORRECTIVE ACTION

The contractor shall establish and maintain a closed-loop corrective action system that ensures problem identification and appropriate management action. The corrective action system shall provide:

1. A method for ensuring that discrepancies and problems are identified and surfaced by the performance management system and are reported promptly to program management for evaluation and processing.
2. A clear identification and definition of potential and existing critical program problems, the cause, and a measure of their impact on program resources, schedule, and performance.
3. A description of courses of action, selection of a recommended course of action, and a schedule for start and completion of designated actions.



4. Assignments of responsibility for corrective-action items to specific organizations and individuals.
5. Continuous monitoring, evaluation, and display of progress being made toward completing the action.
6. An evaluation and closeout of completed corrective action and conduct of followup action.
7. A method for ensuring that corrective actions that affect cost, schedule, or technical performance are reflected in related schedules, budgets, and technical performance documentation.

### 3.5 CUSTOMER REPORTING

Customer reports provide management-level visibility and performance measurement assessment. Report requirements are:

1. The contractor shall provide NASA a single-source document covering the elements of cost, schedule, and technical performance, including integrated analysis, on a periodic basis mutually agreed upon at contract go-ahead.
2. The document shall provide management-level visibility through the use of charts, graphs, and narrative analysis to communicate status and program performance at a practical management level.
3. Specific problem areas and special situations shall be highlighted on a by-exception basis by providing in-depth detail data normally used by functional departments in performing their regular management functions.
4. Supplementary data such as computer runs, accounting data and similar material shall be provided as stated requirements per data requirements list (DRL) and data requirements description (DRD) agreements.
5. The report shall nominally be at NASA Level 4 and shall include summary program status; vehicle and subsystem status; facility and support-equipment status; major milestone status; earned value charts and analysis; by-exception analysis of significant program problems with attendant resolution plans; resource charts in sufficient detail to satisfy program level management



requirements; monthly technical progress reports, including TPM milestones; and miscellaneous specialized reports on a periodic basis as appropriate in keeping with good management practices.

### 3.6 PHASE C/D IMPLEMENTATION PLANS

Plans are required to ensure that the approaches used for implementation of basic program functions and activities are complete and integrated. They are also necessary to establish NASA's understanding and concurrence with respect to what the contractor will do and how he will perform certain significant program functions and activities. Requirements for the plans are:

1. The contractor shall prepare the following plans:
  - a. Management Plan
  - b. Engineering and Development Plan
  - c. Facilities Utilization Plan
  - d. Operations Plan
  - e. Manufacturing Plan
  - f. Test Plan
  - g. Logistics and Maintenance Plan
  - h. Configuration Management Plan
  - i. Quality Assurance Plan
  - j. Reliability Plan
  - k. System Safety Plan
  - l. Data Management Plan
2. Each plan shall define the organization, functions, logic, interfaces, process time lines, and other data required for planning and control of the function or activity
3. The plans shall be top-level descriptions of how the particular function/discipline will be planned, executed, and controlled.



4. The contractor shall make reference in the plans to internal documentation such as functional manuals and procedures that will be used for implementation of the plan.
5. Preparation and delivery of plans shall be in accord with the specifications contained in the Phase C/D contract DRL.



## 4.0 EXTERNAL INTERFACES AND RELATIONSHIPS

The contractor shall assist NASA in planning and controlling interfaces between prime contractors and associate contractors and agencies responsible for commonality management. The prime contractor shall plan and control interfaces between the prime contractor and subcontractor and other company divisions. Requirements for external interfaces and relationships are identified in the subsections that follow.

### 4.1 SUBCONTRACT MANAGEMENT

The contractor shall establish effective subcontract management systems for procurement requirement definition, make or buy, source selection, and subcontract award and control. The systems must support prime contract cost, technical, and schedule objectives. The subcontract management function shall also provide auditable measurement and visibility of subcontractor cost, schedule, and technical performance. The systems shall be responsive to the requirements specified in the sections that follow.

#### 4.1.1 Pre-Subcontract Award

Documented business systems shall be established for the following:

1. Method for determination of buy and purchase items. This includes pre-proposal requirement definition and the make-or-buy decision process.
2. Method for providing long-lead-time analysis and identification of long-lead-time items.
3. Method for acquiring subcontractor proposals responsive to prime contract requirements.
4. Method for proposal evaluation, source survey, and selection of subcontractors.
5. Method for award of subcontracts and purchase orders with flow down of prime contract requirements and compatibility with program objectives.



#### 4.1.2 Procurement Schedules

The following are required:

1. The contractor shall provide material milestone schedules that reflect significant events compatible with the program schedules.
2. Critical schedule support events shall be identified for major subcontracted systems and components that are relatable to the WBS definition.
3. Schedule control provisions shall be provided to accommodate schedule change requirements.
4. Schedule management shall provide schedule performance tracking visibility to ensure program support is attained in direct relation with the program master schedule requirement.

#### 4.1.3 Subcontractor Control

Procedures shall be established for:

1. Management of subcontractor effort to include authorization of changes, measurement of performance, execution of preventive and corrective action, and technical and management direction from the prime contractor.
2. Responsive problem resolution.
3. Submittal of subcontractor periodic progress reports on cost, schedule, and technical performance.
4. Establishment of resident offices in major subcontractor facilities, where appropriate. Responsibilities of top management for both the prime contractor and the major subcontractor shall be identified.

#### 4.1.4 NASA/Subcontractor Interfaces

Procedures shall be established for coordinating and controlling all interface activities, meetings, correspondence, and direction between the NASA/contractor and subcontractor organizations. The procedures shall provide for including responsible organizations—NASA, contractor, and subcontractors—in the communication loop.



## 4.2 INTERDIVISION WORK MANAGEMENT

The contractor shall establish an integrated system for the management of all work authorized to be performed by other divisions of the company. This system shall:

1. Provide a method for identifying and selecting work to be transferred based on special products, facilities, and capabilities of other company divisions.
2. Establish the system, policies, and procedures for authorization and management of work which will assure timely, accurate, and auditable measurement of cost, schedule, and technical performance. This system shall satisfy the intent of the requirements established in Section 3.0, Performance Management.
3. Establish and administer a system for coordinating and controlling all interface activities, meetings, correspondence, and direction between the customer and the performing division organization.

## 4.3 NASA/CONTRACTOR INTERFACE

For effective teamwork between NASA and a prime contractor, it is necessary to establish requirements governing the activities and functions that occur at the customer/contractor interface. The objective of these requirements is to ensure mutual understanding of methods of communication and interaction; to encourage rapid and authoritative transmission of data, direction, and action responses; and to facilitate accomplishment of combined NASA/contractor activities. A further objective is to establish a clear understanding of those program responsibilities reserved by NASA.

### 4.3.1 Contractual Interfaces

Contractual interfaces include program interfaces involving contract changes; verification of compliance with contract provisions, including delivery; incremental funding requirements; and contractually required administrative notifications and reports. These and all other matters of contract administration shall be conducted between the NASA contracting officer or his authorized representative and the contractor's contracting representative.



#### 4.3.2 Program Technical and Management Information Interfaces

1. Program data required by the contract shall be prepared and submitted in accordance with the contract provisions summarized in Section 5.2, Data Management.
2. The contract shall define the technical and business data required to support program reviews, problem resolution, and management decisions.
3. Control and definition shall be exercised to limit the volume of data exchanged and to ensure that the data are relevant and accurate and at the level required to support management decisions.
4. All data exchanged shall be documented and recorded.
5. Management and technical meetings shall be held as required to meet program objectives. These meetings and support required from functional and specialty areas will be controlled through the designated interfacing counterpart responsible for the area in question.
6. All NASA/contractor data and meeting interfaces that may affect any established baseline shall be elevated to the program-manager interface level.
7. Action items resulting from meetings and formal reviews shall be documented by the contractor.
8. After contract go-ahead, NASA/contractor directly interfacing counterparts shall be identified, and their responsibilities, authorities, and limitations shall be defined.

#### 4.3.3 NASA Responsibilities

NASA will be responsible for the following:

##### Design and General Management

1. Provide the program baseline WBS and a concise definition of end items. Include a clear delineation of the prime contractor level of responsibility and the requirements for reporting cost, schedule, and technical performance.



2. Provide overall NASA Manned Spaceflight Program Phasing Schedule defining key milestones of the major elements of the Manned Spaceflight Program such as the space station, shuttle payloads, and data relay satellite system.
3. Provide a master schedule for the Space Shuttle Program to assist contractors in the development of detail planning for their respective programs.
4. Provide a mission traffic model describing each mission and frequency of missions.
5. Establish cost targets and government budget distribution for the orbiter and booster programs.
6. Provide at the contractor's facility appropriate management and technical staff to monitor contractor's activities and to participate in major mandatory inspections and checkout operations.
7. Provide and approve total system requirements and vehicle performance requirements such as system specifications, interface control documents (ICD's) and end item specifications.
8. Provide specification and test data for main propulsion GFE to vehicle contractors.
9. Provide GFP/GFE as defined and approved in the Development Test Plan to support the certification program.
10. Provide wind tunnel facilities and test data for configuration and supporting research and technology data needed to support the Space Shuttle Program design effort.
11. Establish a materials priority list to control the acquisition and allocation of critical materials for orbiter and booster contractors to meet Space Shuttle Program schedule objectives.
12. Provide a list of available government facilities as a basis for contractor-recommended facility selections.
13. Establish responsibilities, authorities, and interfaces for design, development, and management between foreign government participants, NASA, and the associate contractors, together with a definition of procedural or regulatory limitations.



#### Flight Test (Horizontal Flight Tests)

1. Provide facilities at designated test sites for flight readiness, flight vehicle servicing, between-flight vehicle maintenance, and modification and repair, and include provisions for safing the vehicles.
2. Provide operational support at the test site to include data acquisition and reduction and support aircraft.
3. Provide propellants and gases for test vehicles.
4. Provide approval of contractor flight test schedule. (Contractors will manage test program.)
5. Provide flight crew personal safety equipment.
6. Establish the agency responsible for integration of emergency, rescue, and recovery operations with a definition of responsibilities and interfaces.

#### Flight Test (Vertical Flight Tests)

1. Provide launch facility and required facilities at designated test sites for flight readiness, static test firing, flight vehicle servicing, between-flight vehicle maintenance, modification, and repair and include provisions for safing the vehicles.
2. Provide operational support at the test site, data acquisition and reduction, and support aircraft.
3. Provide airborne flight crew.
4. Activate alternate landing sites and recovery fleet, as required.
5. Provide facilities for stopover landing sites and for ferry operations.
6. Provide propellants and gases for flight tests.
7. Provide simulators and training programs for flight and flight support personnel.
8. Provide flight crew personal safety equipment.
9. Provide payload canisters (modules) and payloads as GFE to support test program schedules.



10. Establish the agency responsible for integration of emergency, rescue, and recovery operations, with a definition of responsibilities and interfaces.

#### Operational Phase

1. Provide management for the operational phase covering mission planning, establishment of schedules, and conduct of the missions.
2. Provide operational facilities main base (landing site, maintenance and refurbishment facility, and launch facilities), simulators, and training facilities.
3. Provide facilities and support for static test firing.
4. Provide flight crews for missions.
5. Provide payloads.
6. Conduct all mission planning and provide software to support missions and make available necessary support from selected contractors.
7. Conduct mission operations from pre-launch countdown to landing for both orbiter and booster with support from selected contractors.
8. Provide all mission support items, i. e., MSFN, communication satellites, ground control, and data acquisition and transmission.
9. Establish range safety requirements for all operations.
10. Maintain training program for flight crew proficiency during operational life of program.
11. Provide propellants and gases for mission vehicles.
12. Provide flight crew personal safety equipment.
13. Establish the agency responsible for integration of emergency, rescue, and recovery operations, with a definition of responsibilities and interfaces.
14. Activate alternate landing sites and recovery fleet, as required.
15. Provide support at landing sites for ferry operations.



#### 4.4 ASSOCIATE CONTRACTOR INTERFACE

Contractors having prime contracts with NASA for products that have mutual physical, functional, or procedural interfaces hold an associate contractor relationship to each other. Effective teamwork among such associate contractors dictates that their mutual interfaces be formally defined and controlled by conformance to the following requirements.

1. Joint agreements among NASA, the contractor, and associate contractors shall be negotiated for coordination and control of all interfaces between the customer and contractors involved in the Space Shuttle Program.
2. Agreements shall define hardware, software, and functional interface responsibilities and will specifically establish integrating responsibility for maintaining ICD's as well as authority to resolve differences between the associate contractors.
3. ICD's shall be prepared and maintained in accordance with configuration management requirements.
4. The contractor will be notified and shall participate in NASA-originated interfaces with associate contractors that affect the contractor's program.
5. The contractor shall provide for planning and control of the management and technical interfaces with designated associate contractors.
6. Significant results of these interfaces shall be elevated to the program manager interface level.

#### 4.5 COMMONALITY MANAGEMENT

A broad application of commonality within the Space Shuttle Program is planned to reduce cost in both the development and operations phases of the program. Commonality refers to items that can be developed, procured, or performed in a common manner during Phase C/D activity. It refers not only to hardware, materials, and software common to the orbiter, booster, or associated ground systems, but also to facilities, procedures, and services, such as training and logistics, which apply to common hardware.



#### 4.5.1 General Requirements

Implementation of commonality will require a management system involving NASA and several contractors. Requirements for commonality management are:

1. Identify those hardware items (components, assemblies, sub-systems) that may be common in whole or in part for two or more program elements. Appendix C provides a preliminary listing of commonality candidates.
2. Perform cost effectiveness evaluations and derive an official common-item listing.
3. Assign development responsibility to appropriate NASA center/contractor team and insert in appropriate specifications and contracts.
4. Develop common specifications covering total requirements for program use of item.
5. Establish necessary approval/concurrence procedures between contractors and NASA and between development contractor and using contractor(s).
6. Provide for use of the program change control system for control of the common-item list, common item requirements, and common specifications.
7. Establish methods of procurement for use by both development and using contractors.

#### 4.5.2 Development and Using Contractors

The aforementioned requirements for commonality management require participation of each shuttle element contractor and each responsible NASA center under the overall direction of NASA. Additionally, specific requirements shall be levied on the development and using contractors relative to each assigned common item.

##### Development Contractor

1. Develop vehicle-unique requirements and synthesize total requirements.



2. Prepare procurement specifications, drawings, quality/manufacturing, and certification requirements.
3. Select source(s).
4. Direct the design/development program.
5. Prepare and/or approve the certification plan.
6. Direct or perform the certification program.
7. Procure hardware for assigned space shuttle element.
8. Certify hardware acceptability.
9. Direct failure analysis/corrective action.
10. Change control approval/coordination.
11. Provide for maintenance, repair, and modification at joint operating sites.
12. Manage/conduct the quality assurance program. (Maintain historical documentation file.)

#### Using Contractor

1. Develop and provide vehicle-unique requirements.
2. Review and approve procurement specification, drawings, quality/manufacturing, and certification requirements.
3. Concur in source selection.
4. Monitor design/development program and approve the design.
5. Approve the certification plan.
6. Monitor the certification program.
7. Procure hardware for assigned space shuttle element.
8. Certify hardware acceptability.



9. Request/monitor failure analysis/corrective action.
10. Request/approve change control activity.
11. Request maintenance and modification needs.



## 5.0 ASSURANCE DISCIPLINES

Assurance disciplines are configuration management, data management, maintainability management, reliability management, quality assurance management, and system safety management. The responsibilities and activities of these disciplines cross program organizational lines. Accordingly, special management direction and control are required if overall program objectives are to be attained. The requirements for assurance disciplines are identified in the following subsections.

### 5.1 CONFIGURATION MANAGEMENT

Configuration management, like other assurance disciplines, can materially affect the program cost. Therefore, it requires clear definition in terms of specific requirements to provide a base to determine implementation methods and the degree of performance required. The following requirements shall govern configuration management on the Space Shuttle Program.

#### 5.1.1 General

1. Formal reports shall be limited to those essential for program visibility and control.
2. Configuration change decision authority shall be vested in the program contractor to the maximum extent during design and development.
3. Contractor management systems and documentation shall be capable of providing configuration control on a continuing basis, from initial definition of a product to the final operational use of the hardware and software.

#### 5.1.2 Organization

A configuration management organization shall be established for the Space Shuttle Program to provide the following capabilities:

1. Implement configuration management requirements.
2. Interface with the NASA Change Control Board (CCB) and configuration management organization.



3. Establish progressive configuration baselines.
4. Maintain configuration baseline identification by effective use of internal business systems.
5. Provide an efficient change control system for planning, authorizing, and implementing configuration changes.
6. Conduct configuration audits of deliverable end items.

#### 5.1.3 Configuration Identification

1. Configuration identification for the Space Shuttle Program shall be accomplished by establishing formal program baselines and managing identified changes to these baselines.
2. Program baselines shall be established at scheduled formal NASA reviews.
3. Reviews or audits shall verify the accomplishment of contract technical requirements for the current phase of the program and establish a baseline of contract technical requirements for the contract end items that are planned for development in the next phase of the program.

#### Preliminary Design Review (PDR)

1. PDR's shall be conducted incrementally for each end item in the program acquisition phase early in the detail design process to evaluate the progress and technical adequacy of the selected design approach.
2. PDR's shall determine compatibility with the program technical and performance requirements.
3. PDR's shall establish the existence and compatibility of the requirements for the physical and functional interfaces between the end items and other items of equipment or facilities.
4. PDR's shall establish, by NASA approval, a design requirements baseline for the space shuttle Phase C/D design development.
5. The acceptability of the defined engineering approach for each end item shall be determined through the review of preliminary designs, engineering analyses, test data, mockups, breadboards, and interface identification between each end item.



6. A review shall be made of the qualification test plans to verify that the performance requirements of the development specifications will be demonstrated during the test activities.
7. PDR's shall be conducted in separate subsystem review increments which are a joint review of support equipment with vehicle requirements.
8. A summary PDR shall be conducted as a total systems review.

#### Critical Design Review (CDR)

1. CDR's shall be conducted by the contractor for each end item not later than the 100-percent design release date.
2. CDR's shall determine that the detail design of the end item under review satisfies the design requirements established in the end item specification.
3. CDR's shall verify that the physical and functional interface requirements previously agreed to with associate contractors and NASA are accurately depicted on the detail design documents.
4. CDR's shall verify that the released design is identical or equivalent to that used or to be used in the qualification test program.
5. CDR's shall be conducted in separate subsystem review increments for program elements and by system/site for the support equipment. A summary CDR shall be conducted as a total systems review.

#### Site Readiness Review (SRR)

The SRR is the technical evaluation of the operational readiness of facilities, equipment, and instrumentation at the site in support of the space shuttle system flight test and operations. The review will be conducted by NASA prior to the first use scheduled for flight or launch of a space shuttle vehicle. The contractor shall support the SRR by providing:

1. Documentation to verify satisfactory completion of tests required by program technical requirements.
2. Configuration identification and installation verification records, including modifications made subsequent to product configuration audit (PCA).



3. Representatives to support the NASA review team.
4. SRR's may be conducted in separate system review increments for a given site or station. Any SRR conducted in increments shall be summarized at a total systems review for the given station or site.

#### Flight Readiness Review (FRR)

The FRR is the technical evaluation of flight testing as verification of design to certify operational flight readiness of the shuttle vehicle. The following requirements pertain to the FRR:

1. The FRR shall be conducted by NASA prior to the first horizontal test flight and the first mated vertical flight for the first vehicle only.
2. The contractor shall prepare a report of the significant events that occurred during previous testing, a general assessment of hardware readiness, a status of mission support systems, and a summary of unresolved significant program problems.
3. The contractor shall provide the supporting documentation of the activities that cover field modifications and engineering releases during the period of operations.
4. The contractor shall provide technical representatives to support NASA review teams and boards.
5. The FRR may be conducted in separate system review increments for the shuttle vehicle.
6. Any FRR conducted in increments shall be summarized at a total systems vehicle review.

#### Product Configuration Audit (PCA)

The PCA shall be performed to establish a product configuration baseline. The following requirements apply:

1. The PCA shall be conducted on a deliverable configuration end item, preferably the first article scheduled for operational inventory or suitable for system integration, whichever is first.



2. The PCA shall delineate and establish a product configuration baseline by the approval of the baseline data, certifying the as-built configuration, certifying design is complete, and identifying subordinate hardware and software criticalities.

#### Technical Requirements

The following requirements pertain to end item technical requirements:

1. The program specification tree shall identify the required end item specifications and their relationships to each other and to the system specification.
2. Functional requirements shall be allocated from the systems specifications for end items and interfaces.
3. The approved system specification and the development specifications shall establish the design requirements baseline.
4. Program configuration control of changes to approved baselined end item specifications shall be formally maintained.
5. End item specifications that have had changes incorporated prior to contract go-ahead for the next program phase shall be identified by an "alpha" revision suffix.
6. End item specification changes occurring subsequent to preparation of the "alpha" revision shall be incorporated into the baseline document by specification change notices (SCN's).
7. The contractor shall prepare SCN's for each Class I change affecting an approved end item specification and submit the SCN as part of the engineering change proposal (ECP).
8. After the ECP has been approved, revised end item specifications replacement pages shall be distributed by the contractor to all specification holders.



#### 5.1.4 Change Management

The following requirements pertain to change management:

1. The Space Shuttle Program change management system shall provide the means to control changes to the established configuration baselines through formal change-control procedures and appropriate management level change authorities.
2. Changes to a baseline shall be identified, processed, and approved through a uniform system that will provide a complete definition of the change in terms of:
  - a. Reason for the change
  - b. Effect on specifications
  - c. Effect on drawings
  - d. Effect on interfaces
  - e. New and old part numbers
  - f. Configuration item serial number effectivity
  - g. Change implementation schedule
  - h. Cost of change
  - i. Revisions to assigned WBS element or work package (task, schedule, cost)
3. All proposed changes to baseline documentation shall be classified as either a Class I or a Class II change.
4. Any change to a baselined document that affects stated requirements (i.e., performance, design, reliability, maintainability, interface, test, interchangeability, or configuration), program schedules, and WBS's or contract cost or commonality shall be defined as a Class I change.
5. Class I changes must be approved by the NASA CCB or delegated to the local NASA representative.
6. Any change that is below the level of requirements definition in currently baselined documents shall be defined as a Class II change.



7. Changes to baselined documents to correct errors (i. e., typographical, missing dimensions, etc.) shall also be defined as Class II.
8. Class II change documentation shall be approved by the contractor, and copies of Class II changes shall be provided to the local NASA representative on request.
9. Each change proposed against a baseline shall be assigned a unique change identification number.
10. The assigned number shall be used to "package" the complete change.
11. All change documents used to propose, approve/disapprove, and to implement an approved change shall use the same change number for identification.
12. A current record shall be maintained by a single function that identifies the authorized configuration documents (including changes/revisions) released for production and/or test.

#### 5. 1. 5 Configuration Accounting

The following requirements pertain to configuration accounting:

1. A configuration accounting system shall be established and maintained to provide a means of identifying all documents that define a configuration baseline. The system will record manufacturing and inspection data to identify the product hardware configuration and installation verification.
2. All changes to the design configuration baselines shall be recorded, and the system shall provide status reports of change verification for the program hardware life cycle.
3. The contractor's reporting system shall be based on the concept that the principal provisions and report usage will be identification of a requirement.
4. Reports shall satisfy common requirements for internal and NASA configuration, identification, or status information.
5. Comparative (as-designed and as-built) configuration data shall be furnished for acceptance data requirements for delivery of end items.



#### 5.1.6 Interface Management

An interface group will be established to resolve interface problems, document interface agreements, and coordinate change proposals for submittal to the customer.

This group shall consist of at least one representative from each of the participating NASA centers and contractors with the chairman designated by NASA. Only those program participants involved in the particular change will be required in attendance at the meetings.

#### Interface Control Documents

Establishment of system interface control requires identification and definition of interfaces, scheduling, preparation, approval, release, and control of formal interface control documents (ICD's).

1. The ICD's for the space shuttle system shall be used to record the design agreements between associate contractors, as authorized by NASA, and shall, with production drawings, facility construction drawings, and specifications, provide a means to control design parameters at interfaces between system segments.
2. Interface control drawings shall initially be based upon the requirements of the specifications which contain the interface requirements.

#### ICD Change Control

1. Engineering change proposals originated by an associate contractor and that affect an interface shall be reviewed by the interface group for certification of technical agreement prior to submittal.
2. When the interface group cannot agree on resolution of an interface problem, specific direction from NASA shall be requested.
3. Changes initiated by NASA shall be reviewed by the interface group for interface impact and resolution of any identifiable interface problems.

#### 5.1.7 Subcontractor Configuration Management

1. Requirements established for the Space Shuttle Program shall be applied to subcontractors and suppliers to the extent necessary for configuration control of the product being procured, including requirements for maintainability, safety, and logistics support.



2. Subcontractors shall be required to maintain a systematic approach to configuration identification, drawing preparation and release, change management, and configuration status accounting. Design reviews shall be scheduled and conducted to support program milestones. Configuration reviews shall be conducted on all development items procured.

#### 5.1.8 Configuration Management Reviews

1. Reviews of configuration-management-related systems shall be conducted for validation of effectiveness in meeting configuration management requirements.
2. Reviews shall be performed internally to verify the adequacy of system interfaces between functional elements.
3. Major subcontractors shall also be reviewed to establish conformance to requirements.

### 5.2 DATA MANAGEMENT

Specific attention to the management of data is required to ensure their timely delivery, currency, proper initial distribution, and retrievability.

To achieve innovative approaches and cost reductions in the production and management of data, the contractor shall selectively identify program data requirements he believes will suffice for NASA to perform its management surveillance of the program. These data will normally be the same data required by the contractor for internal control.

The system by which the contractor plans, manages, and produces contractually deliverable data shall be similar to that by which hardware is planned, managed, and produced. The contractor shall identify and define those requirements for management of data that will provide positive control of contractually specified data and noncontractual supporting data.

#### 5.2.1 Deliverable Data

The contractor's system for management of deliverable data shall meet the following requirements:

1. All contract data shall be prepared as directed by the contract data requirements description. The contractor's existing format and document numbering systems shall be used to the fullest extent. Responsibility for preparation of each data item shall be identified to a specific accountable manager.



2. Preparation and delivery schedules for contract data shall be identified in program schedules. Schedule milestones and events planned for data items to provide program management progress visibility and to identify those items requiring corrective action shall be identified.
3. The system shall control internal and external distribution of each data item and include records of such distribution. Records shall also be maintained of specific documents approved by NASA.
4. The contractor's change control system shall provide for timely incorporation of engineering and contract changes into the affected data items. It shall also provide for definition of changes to data items as an integral part of the change description contained in documents authorizing changes.
5. The system shall provide for data retention and storage, in accordance with contractual requirements, of all pertinent prime and subcontract documentation.

#### 5.2.2 Government-Furnished Data

The contractor's system for management of government-furnished documentation supplied for the contractor's internal use shall conform to the following requirements:

1. Each contractor request for such data shall be recorded.
2. A record of receipt shall be maintained.
3. Internal distribution shall be made to contractor personnel in need of the data. Records of such distribution shall be maintained for the purpose of updating in the event of superseding changes.
4. An appropriate place for storage shall be provided, and a system of indexing and retrieval shall be maintained.
5. Disposition shall be made in accordance with contract requirements.

#### 5.3 MAINTAINABILITY MANAGEMENT

The contractor shall establish and maintain an effective maintainability program for implementation and control of all program maintainability requirements in a cost effective manner. This maintainability program will apply to the design, development, and operation phases of the Space Shuttle Program. The maintainability system shall meet the following requirements:



1. The contractor shall assign a single-point function within his organization the responsibility for the planning, implementation, and control of the maintainability program.
2. The contractor shall designate one individual responsible for directing and managing the maintainability functions reporting at the level required to appropriately discharge all contract responsibilities.
3. The contractor shall ensure that maintainability procedures and control documentation are adequate to achieve program maintainability objectives.
4. The contractor shall ensure that all designs selected for shuttle usage have been influenced by maintainability criteria (evaluation at the drawing-board level) and, as applicable, by quantitative evaluation techniques. These processes shall identify potential problems and assure compliance with governing criteria.
5. The contractor shall provide a formal program of maintainability management review of all proposed designs.
6. The contractor shall develop a listing of measurable design requirements for shuttle vehicle subsystems.
7. The design requirements shall include removal-and-replacement elapsed time and/or servicing-and-maintenance-access elapsed times for selected critical line replaceable units to the subsystem level.
8. The basis for apportionment shall be that reasonable apportionment allocated for maintenance of a two-week turnaround operation. Refinement of allocation through tradeoff and evaluation shall be accomplished.
9. The contractor shall conduct tradeoff evaluation studies for maintainability concepts, methods, subsystem apportionments, and problem areas to assure that the best overall approach is accepted and that other functional factors such as reliability, safety, manufacturing, and quality are considered.
10. The contractor shall ensure that appropriate maintainability requirements are incorporated into design and procurement specifications for subcontractor- and vendor-supplied items and that procedures for surveillance and control are established.



11. The contractor shall establish a system to verify that maintainability and requirements have been incorporated into design.
12. Maintainability verification shall be accomplished in consonance with other functional requirements during the development, production, and test phases.

#### 5.4 RELIABILITY MANAGEMENT

The contractor shall establish a reliability management system to ensure control and accomplishment of all reliability program tasks in a cost effective manner through design, development, and operations of the Space Shuttle Program. This system shall be designed to meet the following general requirements and the detailed requirements specified in Appendix D.

##### 5.4.1 General

1. A reliability program plan that defines the program requirements and identifies the implementation methods.
2. A single-point function within the program organization with the responsibility for the planning, implementation, and control of the reliability function.
3. A head of reliability who shall devote full time to the reliability effort and report at a level as required to appropriately discharge all contract responsibilities.
4. Monitoring of all reliability program tasks by reliability management to assure that they are effectively accomplished and that program reliability requirements are met where reliability tasks are delegated to other organizational groups.
5. Supplier reliability controls to assure procured hardware compatible with program reliability requirements.
6. Appropriate provisions for NASA visibility of program status, effectiveness, resource expenditure, and identified problem areas.

##### 5.4.2 Design Specification

1. Assurance that appropriate design specifications/product control documentation is generated and maintained and that these documents are adequate in support of program reliability objectives.



2. Assurance that revisions are made when specifications become obsolete or out of date.
3. Independent reliability review of selected program specifications.

#### 5.4.3 Reliability Evaluation

1. Provision of procedures to ensure that all designs selected for shuttle usage have appropriate reliability evaluation through qualitative and, as applicable, quantitative analysis techniques.
2. Use of evaluation techniques to identify potential problem areas to assure compliance of each configuration with program criteria.

#### 5.4.4 Failure Mode Effects Analysis

1. Performance of detailed failure mode effects analyses (FMEA's) on candidate configurations early in the design phase.
2. Identification of deficiencies or needs, such as single failure points (SFP's), potentially hazardous conditions, critical items for emphasis, need for redundancy, etc.
3. Maintenance of a continuing effort to eliminate or minimize the effect of single failure points throughout the program.

#### 5.4.5 Maintainability

1. Assurance that designs developed by the contractor provide maintainability features based on reliability experience and analytical studies.
2. Identification of those components, considered in the design, which will require frequent removal because of known limited life or age-sensitive characteristics, as well as hardware with unique maintenance and adjustment problems.
3. Assurance that maintenance planning reflects program reliability experience with an optimum mix of both preventive and curative measures.

#### 5.4.6 Design Review

1. Provision of a formal program of engineering management evaluation of all proposed designs.



2. Performance of design reviews at the system, subsystem, assembly, and component levels consisting of comprehensive critical audits of all pertinent aspects of the designed hardware and software which affect reliability requirements.
3. Identification and documentation of potential design problems to assure action assignments in order to achieve reliable designs.

#### 5.4.7 Problem Reporting and Correction

1. Evaluation of technical problems associated with hardware and software (such as failures, discrepancies, nonconformances, etc.) for a continual upgrading of the system configuration.
2. Provision of a controlled problem reporting system for reliability, quality, and safety disciplines which will be implemented commencing at the hardware development phase of the program.
3. Assurance that the problem reporting and correction system is a closed-loop system that identifies, verifies, tracks, and documents correction of quality, reliability, and safety hardware problems as well as associated software nonconformances.
4. Provision of an ALERT action system which will be responsive and effective in Space Shuttle Program ALERT activities.
5. Assurance that problem definition/status/closeout data are compatible with the NASA problem data bank requirements.
6. Assurance that deficiencies that could affect personnel safety, mission success, or cost-effective vehicle operation have maximum program emphasis for resolution.

#### 5.4.8 Parts and Materials Program

1. Provision of a parts and materials program consisting of selection, specification, application, and qualification controls.
2. Assurance that the parts selection program minimizes the number of part types used.
3. Generation and imposition of a program preferred and standard list as well as other parts and materials program requirements on all using agencies.



4. Maintenance of a where-used accountability system that identifies the location of shuttle vehicle parts and materials.
5. Identification and imposition of data requirements and screening activities for off-the-shelf hardware to eliminate potential reliability problems.
6. Assurance during the design review process that the effects of toxicity, out-gassing, flammability, stress corrosion, and age/life limitations on material applications have been evaluated.
7. Assurance that materials can be controlled by appropriate specifications and all nonmetallic materials have an application review.

#### 5.4.9 Test

1. Establishment of controls for a planned program of testing and application analysis which will ensure that equipment used on the Space Shuttle Program is capable of performing within all anticipated environments and use conditions.
2. Definition of techniques to identify risks and potential problems to assure certification rigor compatible with the program reliability objectives.
3. Assurance of certification program augmentation with an acceptance test program to minimize known fabrication problems.

### 5.5 QUALITY ASSURANCE MANAGEMENT

Establishment of an effective and timely quality assurance program in consonance with NHB 5300.4 (1B) requires implementation of both general and specific quality assurance tasks and management controls.

General requirements for the space shuttle quality assurance program are listed below. Specific requirements are identified in Appendix E of this plan.

#### 5.5.1 Quality Assurance Management Organization

The contractor shall assign a single-point function within his organization the responsibility for planning, controlling, and implementing quality assurance requirements of the program. One individual shall be designated responsible for directing and managing the quality assurance program, and he shall report directly to the program manager.



#### 5.5.2 Quality Assurance Procedures

Effective and timely quality assurance procedures and control documentation tailored to the applicable program phase shall be developed and implemented. Unscheduled audits shall be performed on personnel, procedures, operations and associated documentation which affect the quality program.

#### 5.5.3 Quality Information

The contractor shall provide for the collection, processing, analysis, and recording of quality information resulting from the design, procurement, fabrication, test, inspection, and usage of articles and materials procured and produced. Appropriate quality information shall be promptly disseminated to concerned areas within the contractor's organization and to concerned suppliers to effectively implement quality program requirements and contract requirements.

#### 5.5.4 Design Control

1. The contractor shall establish quality criteria and implement a system to ensure its incorporation in the contractor's technical documents such as specifications, procedures, drawings, fabrication and planning documents, and process sheets.
2. Quality Assurance shall participate in design reviews to ensure that designs permit and facilitate producibility, repeatability, and inspectability and that related quality considerations are defined and incorporated in applicable technical documentation.
3. The contractor's quality assurance organization shall be responsible for control of all quality-generated documents and changes thereto and shall verify that changes are accomplished as authorized on affected articles or materials.

#### 5.5.5 Procurement Quality Controls

The contractor shall assure that procured materials and services meet specification requirements and quality criteria. This assurance shall be obtained by review of applicable documents, effective selection of sources, technical assistance and training, assignment of surveillance personnel, and receiving inspection.

#### 5.5.6 Fabrication Quality Control

The contractor shall provide quality surveillance of fabrication and assembly operations to ensure that characteristic and design criteria specified in technical documents are included and maintained in all contractor-fabricated articles.



#### 5.5.7 Inspection and Test

The contractor shall conduct an inspection and test program that demonstrates that contract, drawing, and specification requirements are met to provide maximum assurance that the quality inherent in the design is maintained.

#### 5.5.8 Nondestructive Evaluation

1. The contractor shall use nondestructive evaluation techniques to determine the integrity of structures during manufacturing and to support in-flight and turnaround operations.
2. Specific methods shall be established to substantially reduce inspection time during manufacturing and turnaround.
3. Where necessary, on-board nondestructive evaluation methods shall be established to provide a timely data readout of structural integrity to support maintenance operations for turnaround.

#### 5.5.9 Nonconformance Control

The contractor shall establish a nonconformance and corrective action system that provides for the identification, recording, review, and disposition of materials and articles that do not conform to applicable drawings and specifications. The system shall include a material review board and shall ensure that appropriate corrective and preventive actions are initiated and resolved upon identification of adverse quality trends.

#### 5.5.10 Metrology

1. The contractor shall implement a metrology system to control measurement processes to ensure the accuracy of hardware conformance to design requirements.
2. Measurement standards, gauges, and measuring, inspection, and test equipment, including production tooling and automated equipment, shall be selected and controlled to the degree necessary to meet the requirements specified in Appendix E.

#### 5.5.11 Stamp Control

The contractor shall implement a stamp control system to ensure (1) that stamps are applied to articles and materials (and related records) to indicate fabrication and inspection status, (2) traceability to responsible individuals, (3) that stamping methods and marking materials are compatible with the articles and their use.



#### 5.5.12 Handling and Storage

Articles and materials shall be suitably protected, marked, labeled, and packaged to protect them during all phases of fabrication, processing, and storage from deterioration and damage.

#### 5.5.13 Statistical Techniques

The contractor may use statistical techniques such as sampling plans, statistical planning, and analysis to provide effective and efficient control over fabrication and inspection operations.

#### 5.5.14 Government Property Control

The contractor shall be responsible for and account for all government property provided under the contract.

### 5.6 SYSTEM SAFETY MANAGEMENT

The contractors shall establish a system safety program to be effective during the design, development, and operations of the Space Shuttle Program to ensure that all potential hazards are identified as early as possible and that corrective action is taken.

The contractor's program shall meet the following general requirements and the detailed requirements specified in Appendix F:

1. The contractor shall establish a distinctly identifiable system safety organization reporting to one person who has direct access to the program manager. The system shall have clearly defined responsibilities, functions, authority and relationships between line, staff and top management.
2. System safety criteria shall be included in engineering, test, maintenance, and operations documents.
3. Identified hazard classifications and hazard reduction precedence sequences shall be as agreed upon between NASA and the contractor. These guidelines, criteria and requirements shall apply to all contractor and subcontractor activities.
4. System safety analyses, including system logic diagrams, systems hazard analyses, operations hazard analyses, design change assessment, and FMEA's shall be used, where appropriate, to identify potential hazards.



5. A hazards list shall be maintained throughout the program to list identified potential hazards and their classification and status relative to corrective actions.
6. Hazard data collection and flow processes shall be identified in established system safety procedures.
7. The contractor's safety personnel shall participate in design reviews, customer acceptance reviews, flight readiness reviews, and in accident/incident investigations and reviews.
8. The contractor shall periodically conduct in-house, off-site, and subcontractor system safety audits, inspections, and reviews of locations. Results of these activities will be available for NASA review.
9. Contractor safety personnel shall review all test, checkout, and operational procedures and classify and monitor those that are safety critical. Space shuttle vehicle maintenance and turnaround activities shall receive special safety emphasis, and system safety shall participate in each launch readiness decision.
10. The contractor shall impose equivalent system safety requirements on major subcontractors as appropriate to his activities and product.
11. The contractor shall conduct a vigorous safety training and safety awareness program and keep NASA informed of its progress.
12. System safety deficiencies and actual or potential problems shall be reported to program management for evaluation and processing through the corrective action management system.



## 6.0 INTEGRATION

Presented here is an overall summary of the areas that require integration together with a brief statement of the integration activities associated with each area. Further discussion of each area and the integration activities associated with the area is presented in the appropriate volume of the Engineering and Development Plan.

### 6.1 INTEGRATION AREAS/ACTIVITIES SUMMARY

The following subsections summarize the integration activities for all areas of the shuttle system. In this section there is no attempt to define the agency (NASA or contractor) that will accomplish specific activities, only to establish that the requirement exists.

#### 6.1.1 Space Shuttle System

1. Control the system specification; allocate requirements to appropriate end item specification.
2. Perform vehicle synthesis/sizing analysis to assess impact of proposed changes and allocate requirements to the appropriate system element.
3. Control the system level ICD's; chair interface group to assess changes/problems.
4. Prepare and control launch constraints document.
5. Conduct overall planning for initial flight operations.
6. Assess the space shuttle system to assure flight readiness.
7. Accomplish mission planning; establish vehicle utilization, configuration, requirements, and payloads.
8. Establish requirements to achieve uniformity/integration for safety, reliability, maintainability, and quality assurance.



9. Perform periodic reviews to assess program progress, specifically in relation to cost, schedule, and technical performance.
10. Participate in all shuttle system program reviews; e. g. , PDR, CDR, FRR, etc.

#### 6.1.2 Orbiter/Booster Systems

1. Assure integration of all internal vehicle subsystems and their compatibility with the vehicle specification.
2. Verify compatibility between system specification and vehicle specifications.
3. Prepare and control main engine/orbiter and main engine/booster ICD's.

#### 6.1.3 Orbiter or Booster System With Support Equipment and Facilities

1. Define and control orbiter/booster support equipment (SE) requirements.
2. Define facility requirements for compatibility to identified SE.
3. Prepare and control ICD's for vehicle/facility and SE facility interfaces.
4. Identify SE requirements peculiar to orbiter/booster for inclusion at all potential operational sites.

#### 6.1.4 Orbiter System SE With Booster System SE and Combination With Facilities

1. Integration of orbiter/booster SE requirements for operational site.
2. Plan SE/facility complex - design and performance consistent with time limitations.
3. Prepare and negotiate and control SE/facility complex requirements.



#### 6.1.5 Orbiter System With Other Space Program Elements

Prepare and negotiate and control interface documentation.

#### 6.1.6 Orbiter System With TDRS and Other Orbital Communication/Navigation Aids

1. Define orbiter requirements.
2. Prepare and control required interface documentation.

#### 6.1.7 Orbiter System With Payload

1. Establish and control orbiter requirements to accommodate payload spectrum.
2. Establish and control payload requirements that evolve during orbiter development.
3. Prepare and negotiate control-required interface documentation.

#### 6.1.8 Space Shuttle Vehicle Ground and Flight Test Programs

1. Define and establish test objectives for the system and its elements; test objectives will be established on a mission basis.
2. Define specific element requirements for each mission in support of test plan and test objectives.

### 6.2 INTEGRATION ACTIVITIES

The following paragraphs summarize the management-oriented integration activities associated with development of the space shuttle system. The integration activities occur at all levels. No attempt has been made in this plan to segregate or relate the activities to an area (item); i. e., booster/orbiter/etc. However, a correlation can be made by referring to the integration areas/activities summary presented in Paragraph 6.1.

#### 6.2.1 Space Shuttle System Requirements

1. Establish and control system requirements for all functions and allocate these requirements in the system specification to the appropriate contractor specifications.



2. Prepare and control the system specification, which shall be structured so that traceability exists for all requirements to sub-tier (i. e. , orbiter and booster elements, ground systems, etc.) specifications.
3. Review sub-tier specifications to assure that the requirements allocated to system elements are addressed in sufficient depth to ensure achievement of objectives.
4. Assess the allocation of requirements from the space shuttle system specification to, and between, the element specifications on a continuing basis so that the proper balance and structure within the elements of the system may be maintained.
5. Develop requirements and guidelines to assure an integrated approach for achieving quality, reliability, safety, and maintainability in the space shuttle system, compatible with overall requirements.
6. Evaluate the impact of mission/user requirements as new missions evolve.
7. Establish a change control and monitoring system to permit evaluation of the cross effects of changes made to the space shuttle system specification and/or immediate sub-tier specifications. Coordinate changes with participating agencies and development contractors as appropriate. This system will interface with, and work within, the program change control system established by the NASA Change Control Board.

#### 6.2.2 System Studies/Analyses

System-level studies and analyses will be required to resolve major issues that evolve during Phase C/D efforts. Trade studies shall encompass analyses between (1) other operational systems and space shuttle, (2) system elements of space shuttle, (3) system functions and sequences, (4) system requirements and allocations, and (5) alternatives to system design approaches as required to develop parametric design tradeoffs. Particular attention shall be focused on those decisions that involve high dollar cost, technical risks, and time-constraining (e. g. , long lead) factors.



System level studies in the aforementioned areas shall be conducted to provide data/solutions in the following areas:

1. Effect of alternative system requirements on the total program in terms of cost, schedule, and mission capability.
2. Establishment of potential solutions or approaches to solutions of major problems.
3. Determination of impact of major problems.
4. Reporting of deficiencies for corrective action.

#### 6.2.3 Interface Requirements

1. Define and control interfaces between the space shuttle system and other operational elements of the program (e. g. , space station, satellites, MSFN, etc.) and between the major system elements of the space shuttle system (e. g. , orbiter-booster, orbiter-ground, booster-ground, etc.).
2. Prepare interface documentation and delineate interdependent/interacting characteristics existing between two or more items for (a) compatibility, (b) change control, (c) communicating design decisions, (d) establishing space and volume control, and (e) isolating responsibilities.
3. Coordinate/negotiate interface documentation between element contractors and/or between contractors and the NASA to provide multilateral agreement.
4. Include interface documentation by reference in the appropriate specifications schedule completion to meet the earliest need by either element contractor involved in the interface.
5. Establish interface group, chaired by NASA, and including representatives from each involved NASA center and contractor. The group will assure early and rapid identification and resolution of problems involving compatibility between the elements of the space shuttle system.



#### 6.2.4 Program Planning/Status

Systems used for program planning and statusing shall meet the requirements defined in Section 3.0, Performance Management, and fulfill the specific requirements listed below.

1. Assess and monitor program plans and schedules for all contracted elements of the Space Shuttle Program and publish directives establishing requirements and constraints.
2. Evaluate progress of Space Shuttle Program to assure compliance with objectives in terms of cost, schedule, and technical performance.
3. Provide results (including highlighted problems) of these evaluations to shuttle program management for determining overall shuttle program performance.
4. Make recommendations for replanning, consistent with identified problems requiring corrective action, and the method or methods for implementing studies and changes to correct deficiencies.

#### 6.2.5 Evaluation of System Analysis and Tests

1. Evaluate system analyses and test results to assure compliance to the design and performance requirements of the space shuttle system. The evaluations, both formal and informal, shall be oriented toward assuring system integrity prior to committing major design/production resources, and toward identifying system problems for timely implementation of corrective actions.
2. Conduct informal performance evaluations encompassing (1) determination of the documentation to be evaluated; (2) obtaining and identifying paragraphs of the specifications against which evaluation will be performed; (3) ensuring that end item system design meets design requirements; (4) evaluating integrated system test and inspection results against requirements; (5) identifying design performance evaluation problem areas; and (6) initiating coordination to correct unacceptable performance conditions if specified requirements are not met.
3. Provide formal evaluation of technical adequacy of the space shuttle contractor efforts in meeting system performance and design requirements through preliminary design reviews (PDR's) and critical design reviews (CDR's). The baseline for PDR/CDR evaluations of design for each system function shall be the space shuttle system specification and end item specifications.



#### 6.2.6 Operational Planning

Operational and mission planning includes integration of all activities pertinent to fulfillment of the following requirements:

1. Accomplish overall planning for initial mated flight operations from receipt of the individual flight vehicles at the test site through mating, launch mission performance, and recovery. This planning sequence is continued until space shuttle vehicle operational status is achieved. The activity includes development of specific sequencing, time lines, and detailed scheduling through the SE/facility complex along with assignment of task responsibilities with appropriate definition of interfacing requirements.
2. Perform missions planning to establish vehicle utilization, special configuration requirements for accommodation of specific payloads (lead time away), scheduling of SE/facility complex utilization, and assignment of payloads to specific vehicles to minimize modifications between flights. The activity blends all missions within specific time spans and allocates system/vehicle elements for their accomplishment.
3. Prepare plans for cycling of each element (orbiter, booster, payload) through ground operations on a mission-by-mission basis to assure readiness for planned individual mission schedule.
4. Establish and operate training programs for common items, including provision of training aids.
5. Operate and maintain vehicle/SE/facility complex in performance of launch and flight operations.
6. Integrate orbiter and booster SE requirements for the operational site.
7. Plan SE/facility complex and its utilization to minimize duplication of SE end items and assure capability to perform operational cycle within prescribed time limits.
8. Prepare, negotiate, and control SE/facility complex requirements document, which defines quantities, types, and acquisition schedules for SE and facilities and defines design/development/acquisition responsibilities for all SE end items.



#### 6.2.7 Review/Control of Plans

1. Review and approve program plans, e. g. , program management, engineering, quality, operations, system safety, logistics, manufacturing, test, electromagnetic compatibility, maintainability, reliability, and payload development plans.
2. Integrate these program plans with each other and with system requirements as well as with related schedules and overall program requirements.
3. Integrate payload development documents and related schedules with the master program phasing schedule for the space shuttle system.
4. Maintain plans up-to-date consistent with current program requirements.

#### 6.2.8 Change Processing

Develop a program change control system in consonance with the requirements for change management defined in Section 5.1. Configuration Management, of this plan.



## APPENDIX A

### DEFINITIONS

The criteria contained in this volume for the contractor's cost/schedule performance measurement system are to be interpreted according to the following definitions and regulations:

#### APPLIED DIRECT COST (ACCRUED COST)

The amounts recognized in the period associated with the consumption of labor, material, and other direct resources, without regard to the date of commitment or the date of payment. These amounts are to be charged to work in process in the period that any of the following takes place:

1. When labor, material, and other direct resources are actually consumed
2. When material resources are withdrawn from inventory use
3. When material or subcontract software and other nonrecurring resources are received that are uniquely identified to the contract and scheduled for use within sixty days
4. When major components or assemblies are received on a line-flow basis that are specifically and uniquely identified to a single serially numbered end item.

#### APPORTIONED EFFORT

Effort that by itself is not readily divisible into work packages but that is directly related to existing work packages.

#### AUTHORIZED WORK

The effort (1) that has been negotiated and definitized by supplemental agreement and (2) for which firm contract prices have not been agreed to, but for which written contract instructions have been received to proceed with work.



## BUDGET

The resources (measured in dollars, man-hours, or other definitive units) that are formally assigned by the contractor for the accomplishment of a specific task or group of tasks.

## CONTRACT BASELINE

The time-phased values of the total program at NASA Level 3 as identified in the WBS shown in Appendix B, Figure B-1. The baseline total must equal the contract cost as defined below. It represents the sum of direct effort and allocable indirect work budgets and management reserves for the original contract and budgets for government authorized changes. If work is authorized before it is definitized, interim budgets will be used for authorized work until it is definitized.

## CONTRACT COST

The total contract value, excluding fee or profit, consisting of the sum of definitized costs and costs for all government-authorized work not yet definitized.

## COST ACCOUNT

The focal point within the contract WBS at which applied direct costs are accumulated and summarized by WBS and functional organization and the lowest required level at which planned value of work accomplished is compared with planned value of work scheduled and applied direct costs. It is also the WBS level where costs are accumulated for performance measurement purposes. The cost account will normally be further subdivided into work packages and will contain separate identification of cost elements (labor, material, etc.). The cost account will have the following characteristics:

1. A clear definition of work to be performed
2. A specific budget and schedule
3. A designated manager with complete responsibility for completing the assigned work within all performance measurement constraints
4. Be restricted to a single functional organization
5. Apply to a single WBS element



## DEFINITIZED CONTRACT COSTS

Negotiated costs that are formalized in a contractual document such as a Supplemental Agreement.

## DIRECT COSTS

Any cost that can be identified specifically with a particular cost objective. Direct costs are not limited to items incorporated in the end product as material or labor. Costs identified specifically with the contract are costs of the contract and are to be charged directly thereto.

## ESTIMATED COST AT COMPLETION (EAC)

Applied direct costs and indirect costs allocable to the contract, plus the estimate of costs for authorized work remaining.

## INDIRECT COSTS

A general group of indirect expenses such as those generated in manufacturing departments, engineering departments, tooling department, general and administrative departments, and indirect costs accumulated by cost centers within these general groups. Included are general groups of expenses such as general administration and general expense, maintenance and operation of physical plant, library expenses, and use charges for building equipment. Indirect costs derived from overhead cost pools that are added to applied contract costs are to be allocated and controlled by government-approved accounting procedures.

## LEVEL OF EFFORT

That activity that cannot be associated with a quantitatively measurable end product or result and is controlled by time-phased budgets established for that purpose.

## MANAGEMENT RESERVE

The total contract cost less the summed value of all the budgeted effort. This cannot be a negative value.

## ORGANIZATIONAL ELEMENT

A unit of the contractor's organization.



## PERFORMANCE BASELINE

The distribution of time-phased costs from operating organizations to the cost account level. This level will serve as the formal baseline for schedule and cost performance measurements. The sum of work budgets allocated to cost accounts plus management reserves must equal the time-phased budgets and reserves in the contract baseline.

## PLANNED VALUE OF WORK ACCOMPLISHED (PVWA)

The sum of the budgets for completed work packages and completed portions of open work packages, plus budgets for level of effort and apportioned effort activity completed.

## PLANNED VALUE OF WORK SCHEDULED (PVWS)

The sum of the budgets representing the cumulative financial plan from inception to the current report period, including the amount of level of effort and apportioned effort.

## REPORTING BASELINE

The level of reporting to NASA that should typically be at NASA Level 3 of the WBS for total program data and at NASA Level 4 for each primary organizational function, except when lower levels of the WBS are of significant importance to warrant their inclusion.

## SIGNIFICANT VARIANCES

Variances or differences from plan that are great enough to require further review, analysis, or action.

## UNDISTRIBUTED BUDGET

A budget that has been identified and set aside for a specific future task or set of tasks in support of the contract, but that has not been distributed to a specific operating organization.

## VARIANCE MEASUREMENTS

### Budget Variance

Difference between the planned value of work scheduled (PVWS) and actual recorded costs. A negative variance indicates actual costs are in excess of planned budget (PVWS); conversely, a positive variance indicates actual costs are less than planned budget (PVWS).



### Cost Variance

Difference between the planned value of work accomplished (PVWA) and actual costs. A positive variance indicates an underrun of planned cost, i. e., work is being accomplished at a lower cost than planned. A negative variance indicates an overrun of planned cost, i. e., work is being accomplished at a higher cost than planned.

### Schedule Variance

Difference between PVWA and PVWS in the order stated. A positive variance (PVWA is greater than PVWS) indicates the category reported is ahead of schedule and in a favorable position. A negative variance (PVWA is lesser than PVWS) indicates the category reported is behind schedule and in an unfavorable position. By plotting cumulative PVWA and PVWS dollar value curves on a time scale and identifying the PVWA dollar value for the current report period on the PVWS curve, it is possible to measure the difference between PVWA and PVWS (schedule variance) in terms of calendar time.

### WORK BREAKDOWN STRUCTURE (WBS)

A product-oriented family tree division of hardware, software, and services, and other work tasks that organizes, defines, and graphically displays the products to be produced as well as the work to be accomplished in order to achieve the specified product. The following criteria must be satisfied:

1. The WBS must be used to allocate all resources to fulfill contract program requirements and must accommodate the accounting structure for budget and cost purposes and the program organizational structure for responsibility definition.
2. The contractor will structure the WBS from the NASA-provided level (normally the system level) downward to at least the cost account.
3. All subcontracting and major procurement effort will be included at the proper level of the WBS.
4. The WBS must be integrated with the contractor's functional organization in a manner that permits performance measurement for WBS and organizational elements assigned to the contract effort beginning with the cost account level.



## WORK PACKAGES

Detailed short-span jobs (or purchased material items) identified by the contractor and controlled by him in assigning work within his organization and accomplishing work to complete the contract.



## APPENDIX B

### PLANNING DOCUMENTS

#### WORK BREAKDOWN STRUCTURE REQUIREMENTS

The Space Shuttle Program work breakdown structure (WBS) defines the product elements of the program that form a framework for planning, control, and measurement of schedules, costs, and technical performance.

The WBS elements delineate the total Space Shuttle Program products by levels in terms of hardware, software, and significant services that are necessary to achievement of the program objectives.

The major Level 3 segments of the shuttle program are:

<u>Element</u>	<u>Level</u>
0.0 Space Shuttle Program	2
1.0 Orbiter	3
2.0 Main Engine	3
3.0 Booster	3
4.0 Flight Test	3
5.0 Operations	3
6.0 Space Shuttle Management and Integration	3

The contractor shall extend the WBS depicted in Figure B-1 as necessary below Level 4 to facilitate its use as the basis of planning, control, and reporting of program activities. (Element levels below Level 4 depicted on Figure B-1 are provided as suggested contractor extensions and should not be considered mandatory.) The WBS elements shall be used for the derivation and definition of cost accounts and work packages which are basic to the performance management requirements identified in Section 3.0.



## PROGRAM DEVELOPMENT LOGIC REQUIREMENTS

The development logic is for program planning. It identifies the significant program events and establishes their interrelationships. The space shuttle system development logic displays the following key program phases.

1. Design and systems development
2. Flight test development
3. Operations

Summarized are events such as customer commitment of resources to the space shuttle system, its configuration, and system requirements definition; selection and initiation of prime contractor Phase C/D activity; space shuttle system integration during the design phase of system elements such as main engines, the orbiter and booster systems, facilities, and support systems; development of vehicle subsystems, ground test, and flight certification vehicles; flight development phase typified by the horizontal and manned orbital flight test programs; and, ultimately, the operational employment phase of the space shuttle system. Further expansion of the development logic is contained in the Engineering and Development Plan.

Sheet 1 of Figure B-2 provides an overview of the total program. Sheet 2 is an expansion of the overview. Sheet 3 provides a more detailed expansion of activities and events from contract go-ahead through PDR, of the orbiter and booster.

The contractor shall further expand the logic to ensure the correct ordering and sequencing of all tasks and the consequent chronological task loading required to support schedules. Further specific requirements in support of total program planning and detail are given in Section 3.0.

## PROGRAM SCHEDULE REQUIREMENTS

The Space Shuttle Program master phasing schedule (Figure B-3) shows the integrated activities and major milestones of the program through the phases of definition, design, development, delivery, first horizontal flight in June 1976, first manned-orbital flight in April 1978, achievement of operational capability in mid-1979, and ten-year operational life. Program elements include orbiter, booster, main engine, ground tests, and flight tests and operations. Interactions of major Space Shuttle Program elements are identified. Figure B-3 presents the Phase C/D schedule that is

#### CONTRACT BUDGET BASELINE

#### NOMINAL REPORTING BASELINE

- MAINTAIN ORIGINAL RECORDS
- REPORT TO CUSTOMER
- PLAN AND CONTROL TOTAL PROJECT
- TO BE ESTABLISHED AT APPROPRIATE LEVELS

#### NOMINAL PERFORMANCE BASELINE

- COST ACCOUNT PACKAGE (FUNCTIONAL SPLIT OF LEVEL)
- MEASURE PERFORMANCE
- TO BE ESTABLISHED AT APPROPRIATE LEVELS

#### DETAIL PLANNING

- WORK PACKAGES
- 1

NASA LEVEL  
2

3

SUBSYSTEMS  
GROUPINGS

4

PROGRAM

5

STRUCTURAL  
GROUP

L1

BODY  
STRUCTURE

L1.1

AERODYNAMIC  
SURFACES

L1.2

THERMAL  
PROTECTION

L1.3

LANDING

L1.4

DOCKING

L1.5

PAYLOAD  
DEPLOYMENT  
& RETRIEVAL

L1.6

PROPULSION  
GROUP

L2

MAIN  
PROPULSION

L2.1

AUXILIARY  
PROPULSION

L2.2

AIR  
BREATHING

L2.3

AVIONICS  
GROUP

L3

GN&C

L3.1

DATA &  
CONTROL  
MANAGEMENT

L3.2

DISPLAYS &  
CONTROLS

L3.3

COMMUNICATIONS

L3.4

INSTRUMENTATION

L3.5

ORBITER  
SOFTWARE

L3.6

POWER  
GROUP

L4

ELECT./MECH  
POWER  
GENERATION

L4.1

HYDRAULIC  
POWER

L4.2

ELECT. PWR  
DISTRIB. CONDIT.  
& CONTROL

L4.3

ECLS  
GROUP

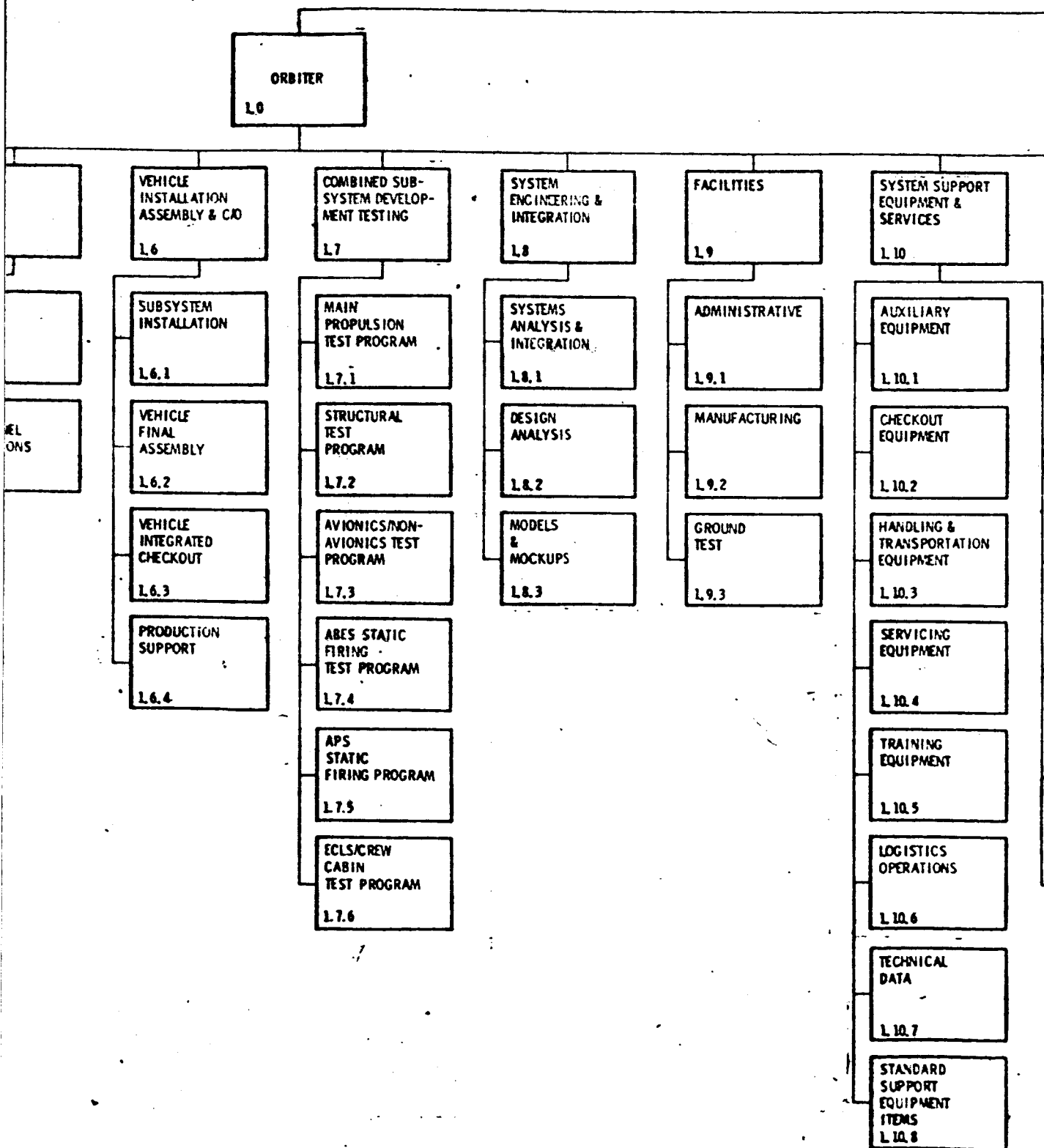
L5

ECLS

L5.1

FLIGHT  
PERSON  
PROVIS

L5.2



MAIN ENGINE

2.0

MANAGEMENT

L 11

PAYLOAD

L 12

PROPELLANTS  
& GASES

L 10.9

ONBOARD  
SUPPORT  
EQUIPMENT

L 10.10

PRODUCTION  
SUPPORT

L 10.11

TRAINING  
SERVICES &  
AIDS

L 10.12

SUPPORT  
EQUIPMENT  
SOFTWARE

L 10.13

TRANSPORTATION

L 10.14

PAYLOAD  
INTERFACE  
PROVISIONS

L 12.1

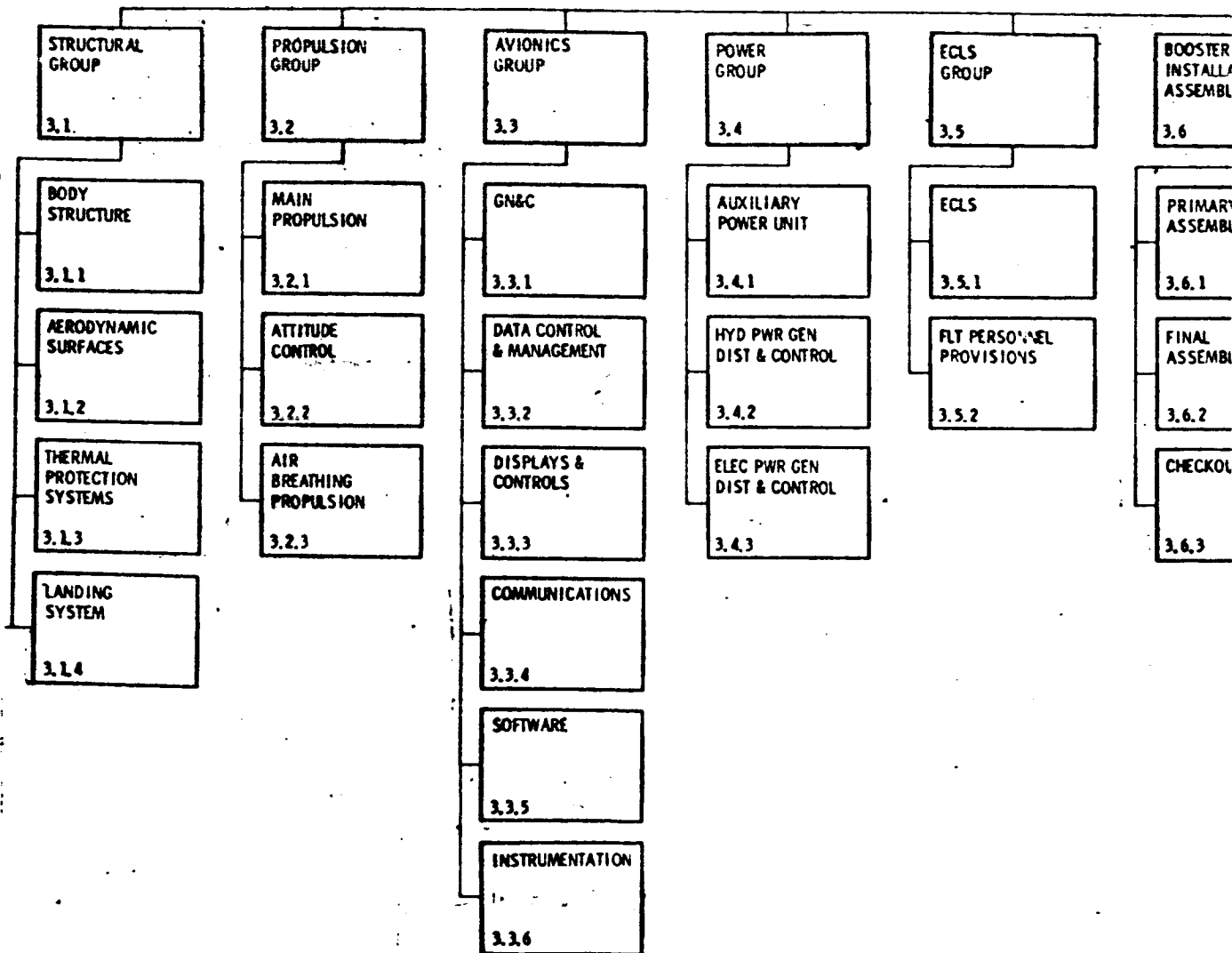
HABITABLE  
MODULE

L 12.2

PAYLOAD  
INTEGRATION

L 12.3

4



SPACE SHUTTLE  
PROGRAM

0.0

BOOSTER

3.0

VEHICLE  
ATION  
& C/O

COMBINED SUB-  
SYSTEM DEVELOP-  
MENT TESTING

3.7

SYSTEMS  
ENGINEERING  
& INTEGRATION

3.8

FACILITIES

3.9

SYSTEM SUPPORT  
EQUIPMENT &  
SERVICES

3.10

BOOSTER  
MANAGEMENT

3.11

MAIN PROPUSSION  
TEST PROGRAM

3.7.1

AVIONICS/NON-  
AVIONICS  
TEST PROGRAM

3.7.2

SEPARATION  
SYSTEM  
TEST PROGRAM

3.7.3

ATTITUDE CONTROL  
PROPULSION  
SYSTEM-ELECT/  
MECH POWER  
GENERATION TEST  
PROGRAM

3.7.4

ENVIRONMENTAL  
CONTROL AND  
LIFE SUPPORT  
TEST PROGRAM

3.7.5

CREW ESCAPE  
SLED TEST

3.7.6

SYSTEMS  
ENG

3.8.1

INTEGRATION

3.8.2

MODELS &  
MOCKUPS

3.8.3

ADMINISTRATIVE

3.9.1

MANUFACTURING

3.9.2

GROUND  
TEST

3.9.3

SUPPORT EQUIP  
(PECULIAR)

3.10.1

STANDARDS  
SUPPORT  
EQUIP.

3.10.2

TRAINING &  
TRAINING  
AIDS

3.10.3

LOGISTICS  
OPERATIONS

3.10.4

TECHNICAL  
DATA

3.10.5

PROPELLANTS &  
GASES

3.10.6

TRANSPORTATION

3.10.7

CONTRACT  
MANAGEMENT

3.11.1

PROGRAM PLAN  
& CONTROL

3.11.2

CONFIGURATION  
MGMT

3.11.3

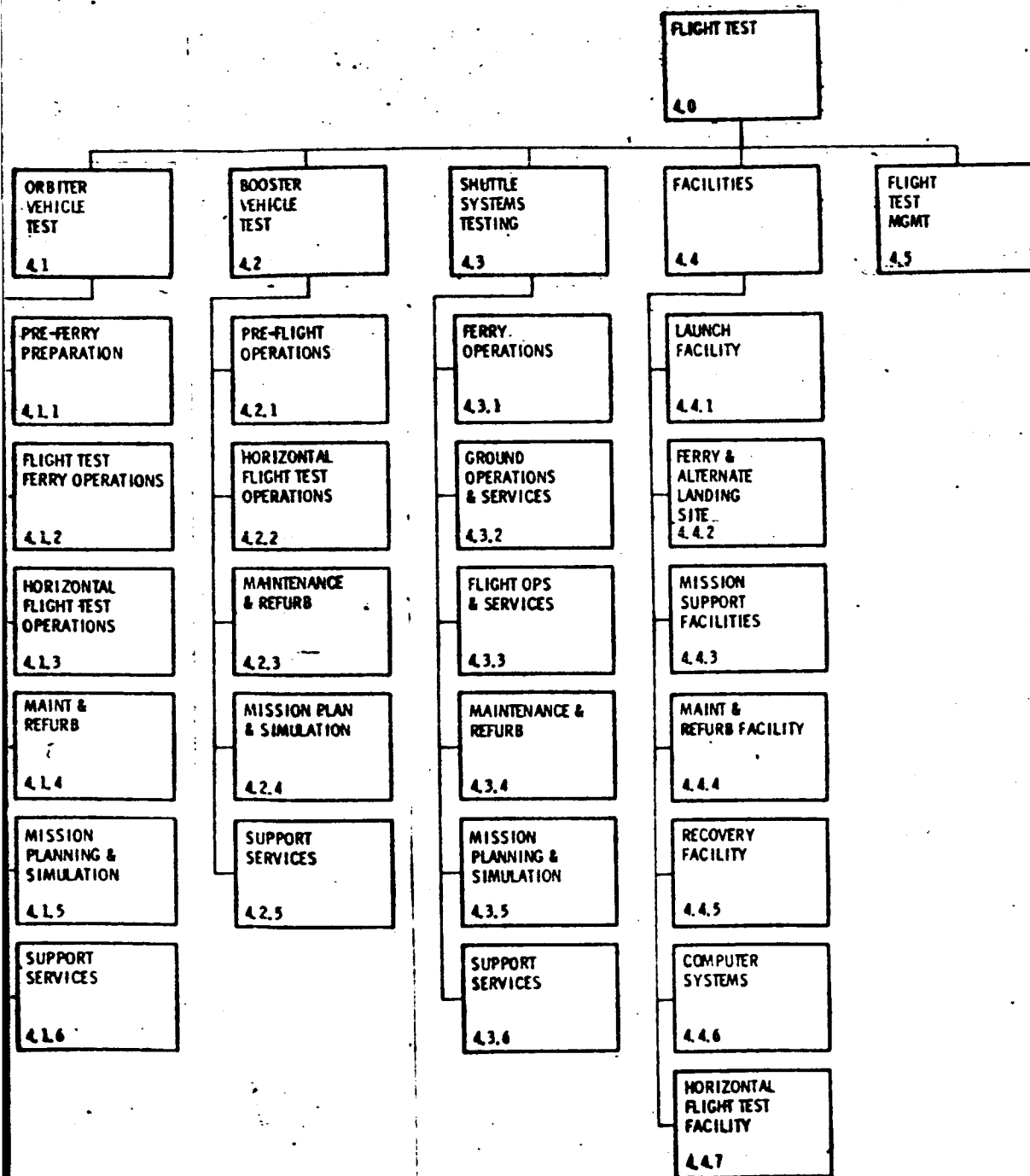
PROGRAM  
DOCUMENTATION

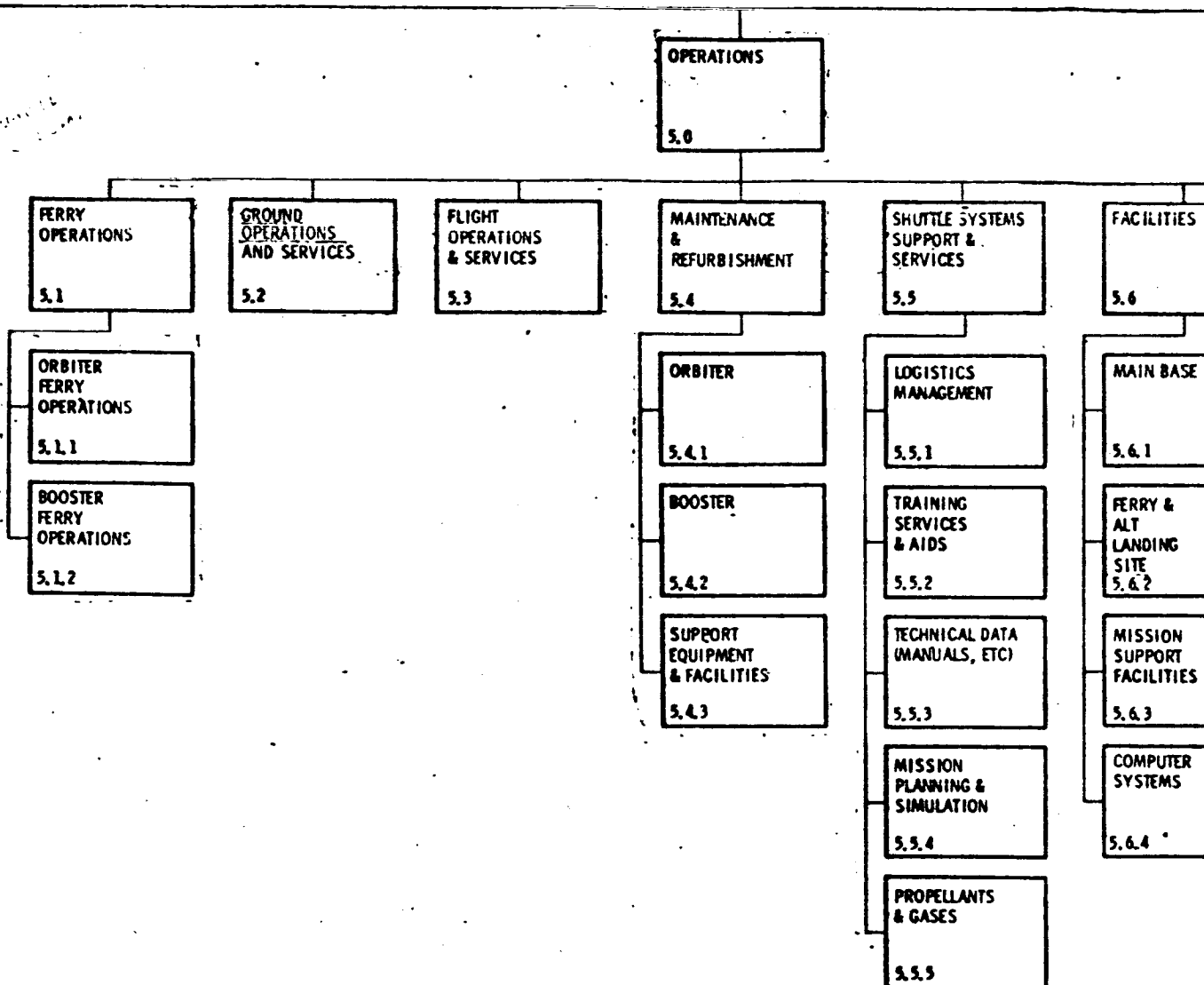
3.11.4

FINANCIAL &  
MANPOWER  
CTL

3.11.5

6







NASA LEVEL

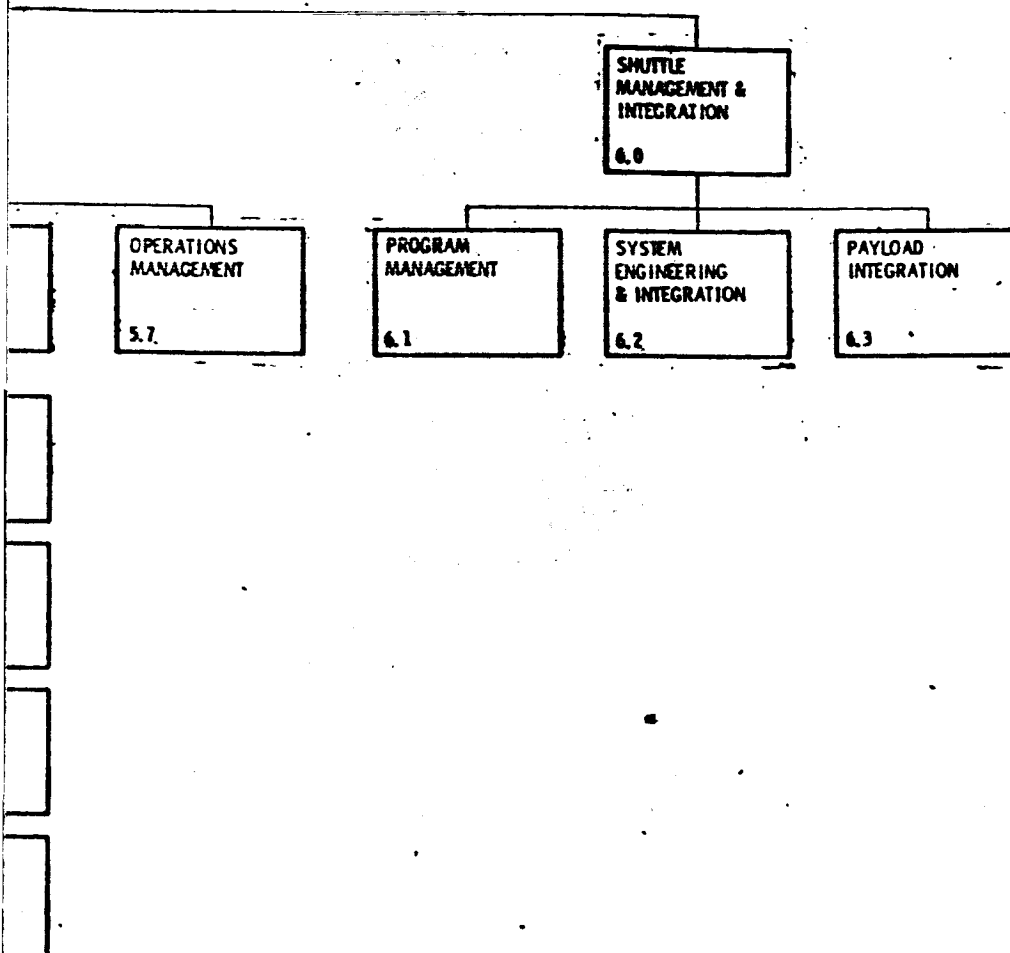
2

3

SUBSYSTEMS  
GROUPINGS

4

5



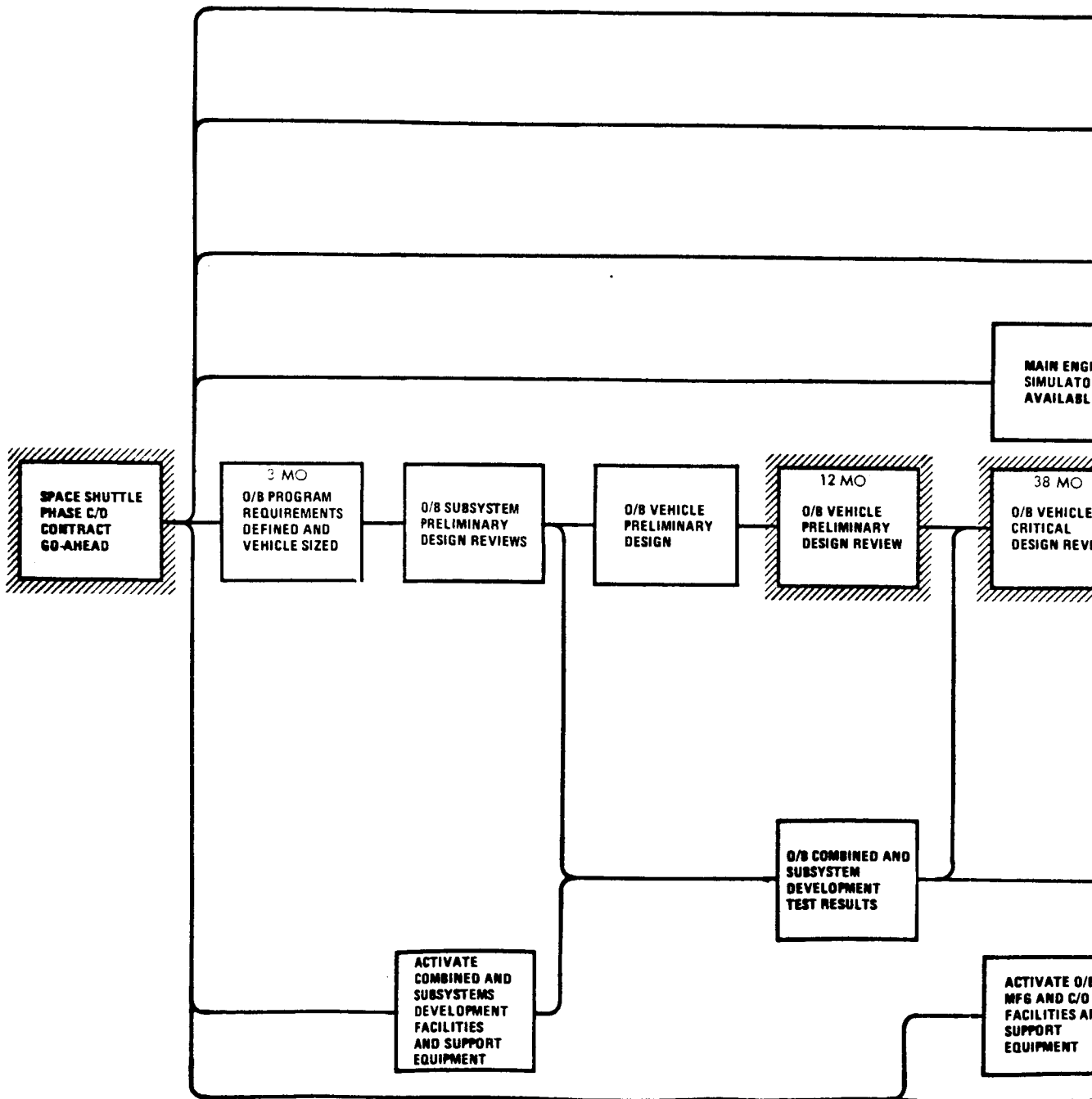
MPS-05 SCA C/D-5-05-01-01  
ORIGINAL 6-25-71  
REVISION 5

Figure B-1. Phase C/D WBS

B-3, B-4

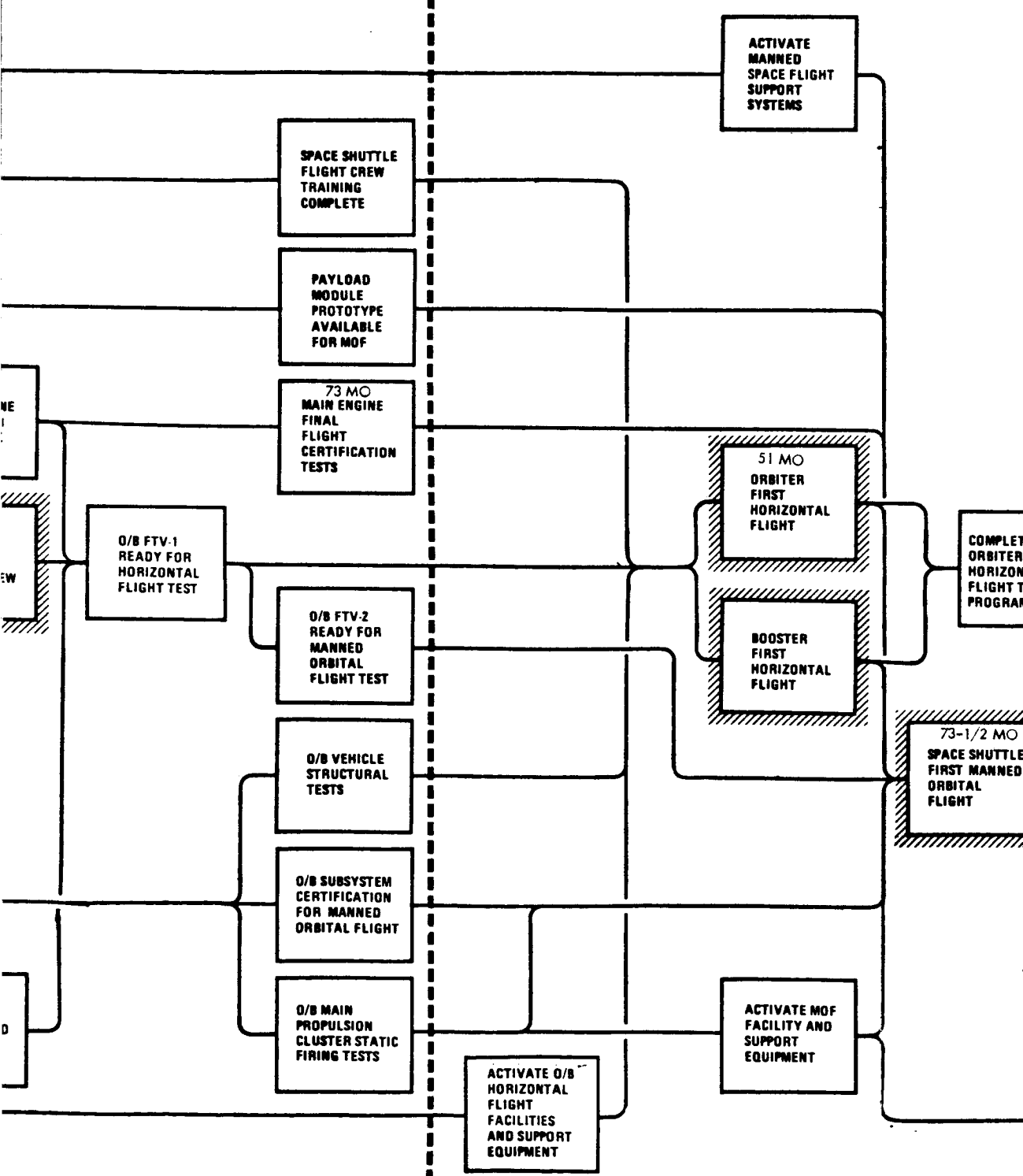
SD 71-101

9



PHASE

FLIGHT TEST DEVELOPMENT PHASE



Figure



## OPERATIONS PHASE

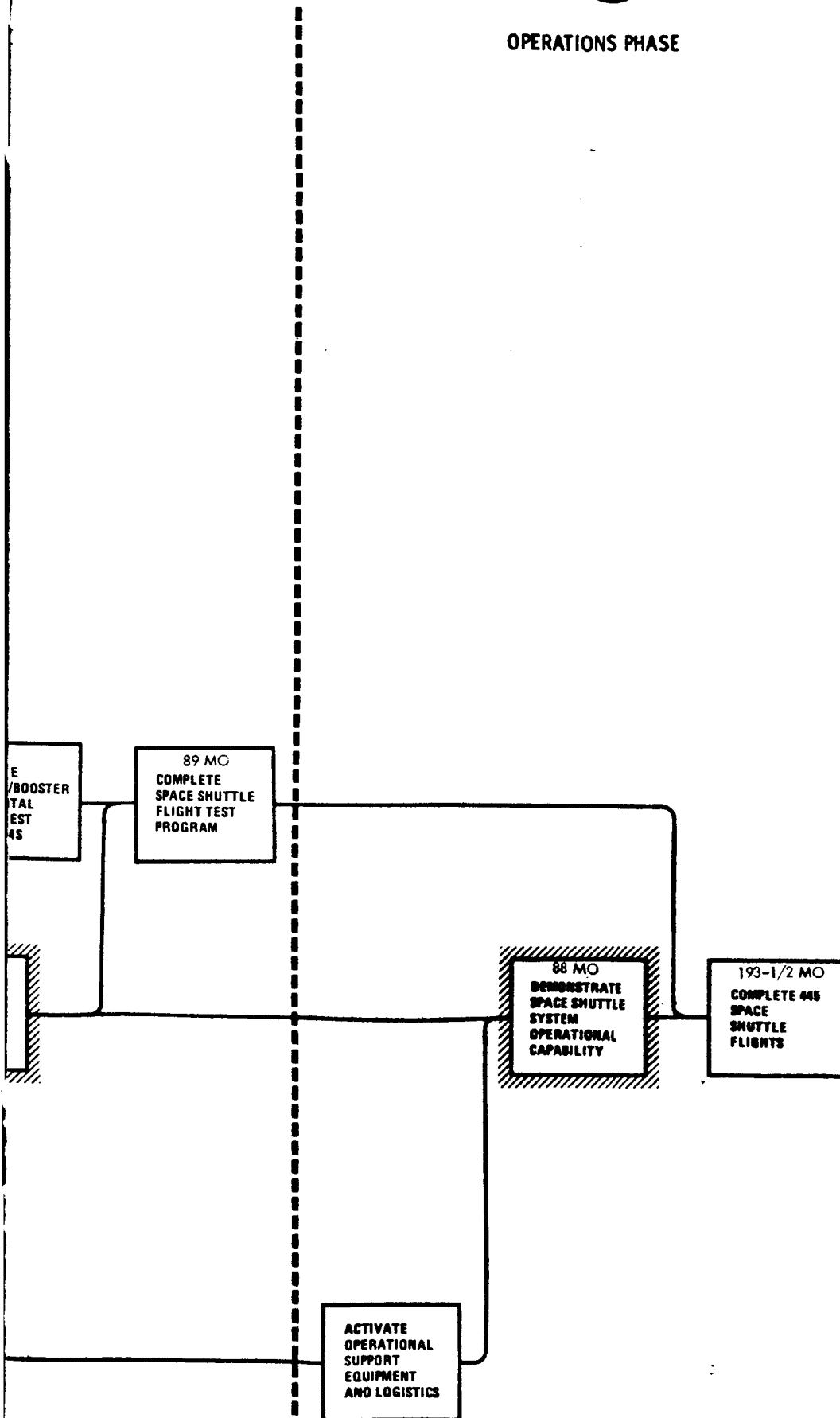


Figure B-2. Space Shuttle System Development Logic (Sheet 1 of 3)

B-5, B-6

SD 71-101

MANAGEMENT & INTE

PAYLOAD MODULE

ORBITER SYSTEM

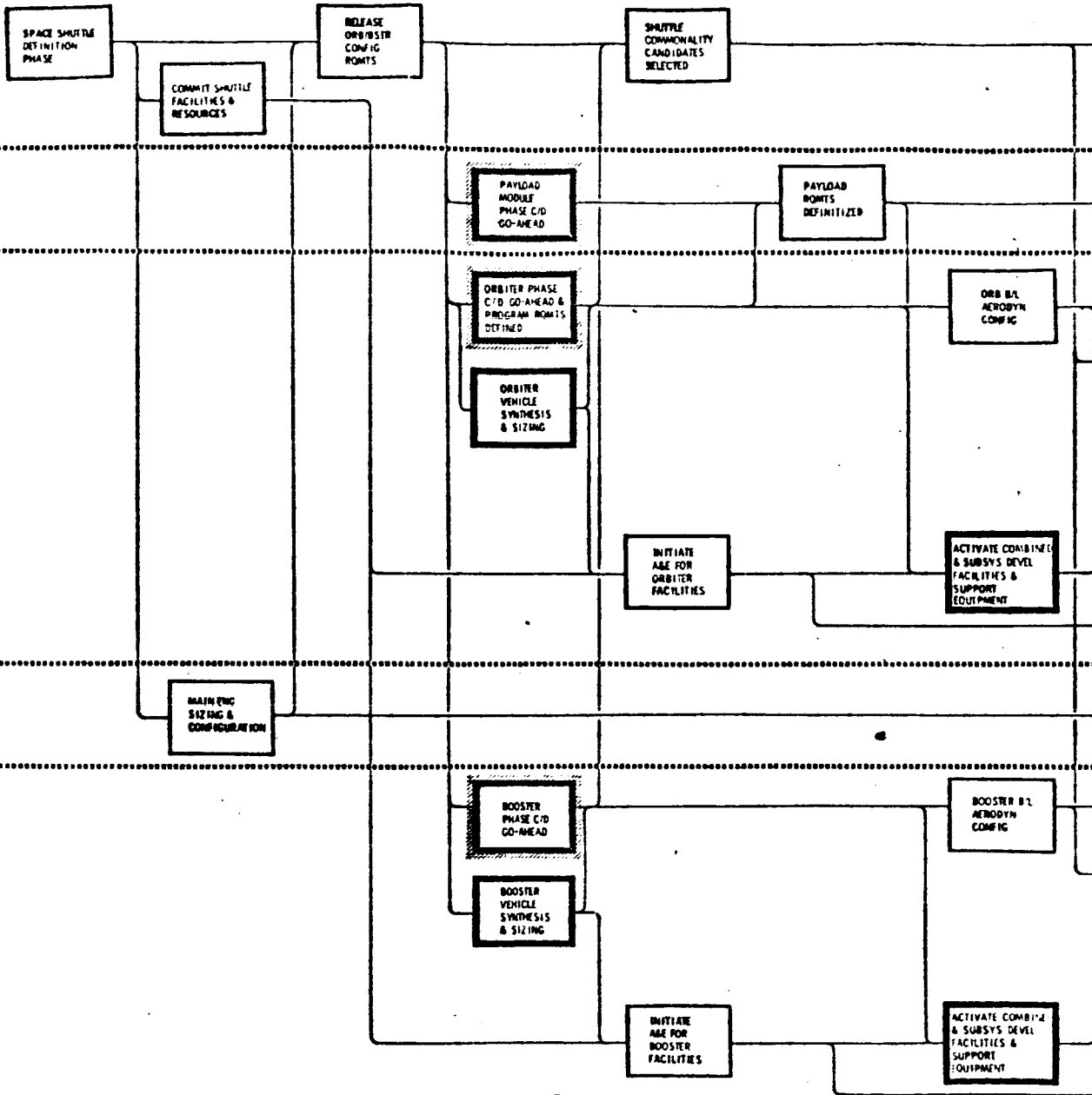
MAIN ENGINE

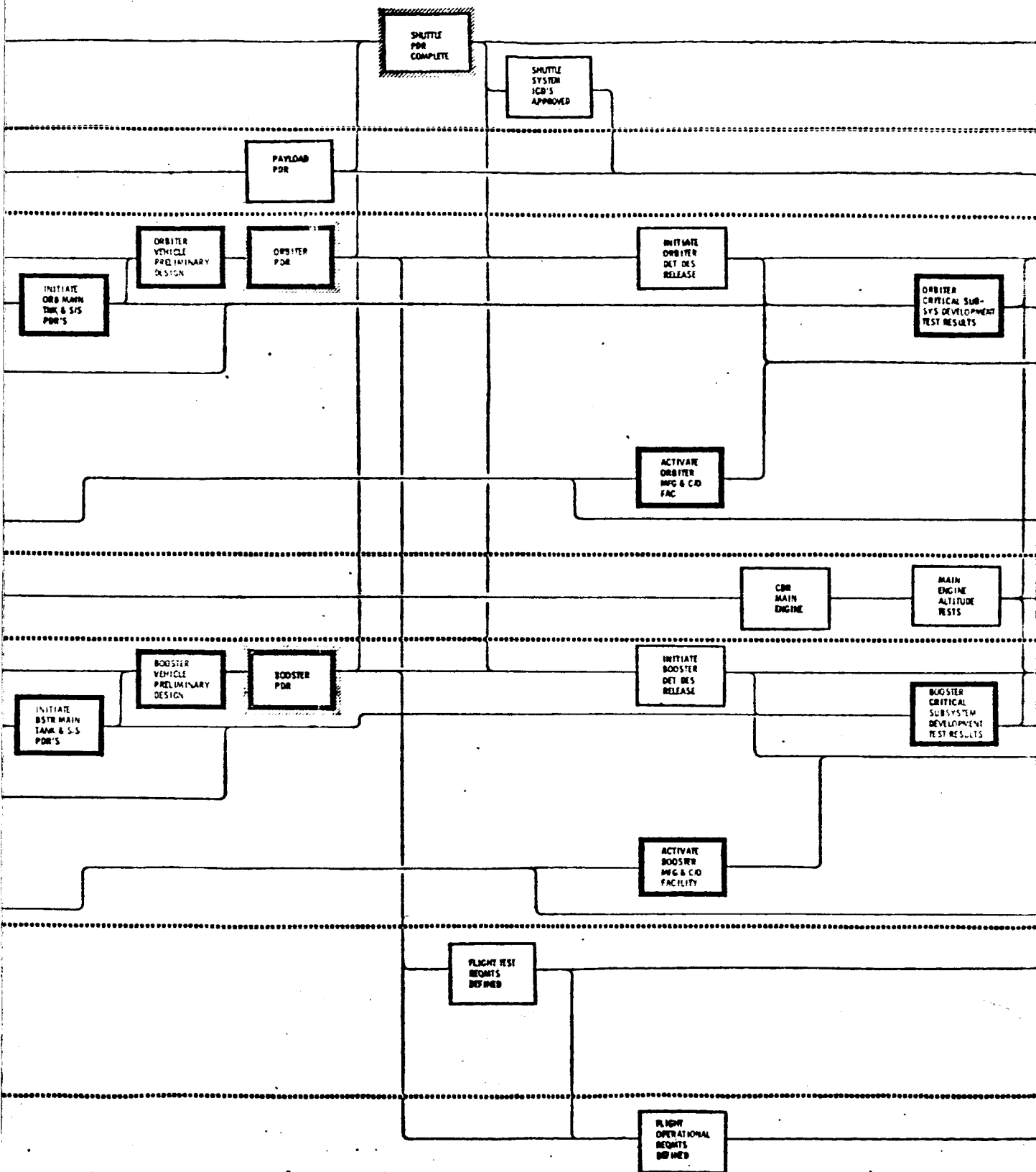
BOOSTER SYSTEM

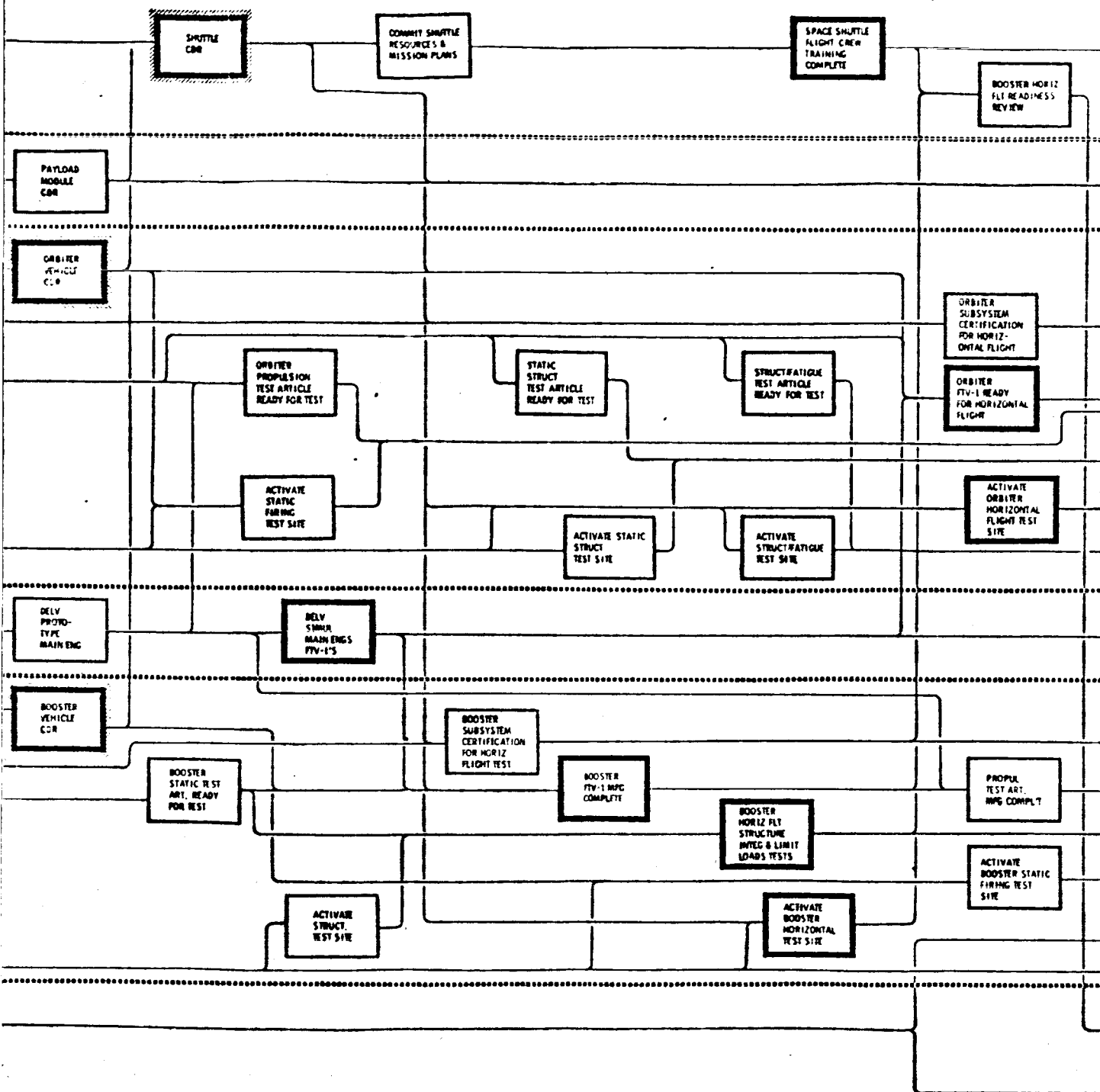
FLIGHT TEST

OPERATIONS

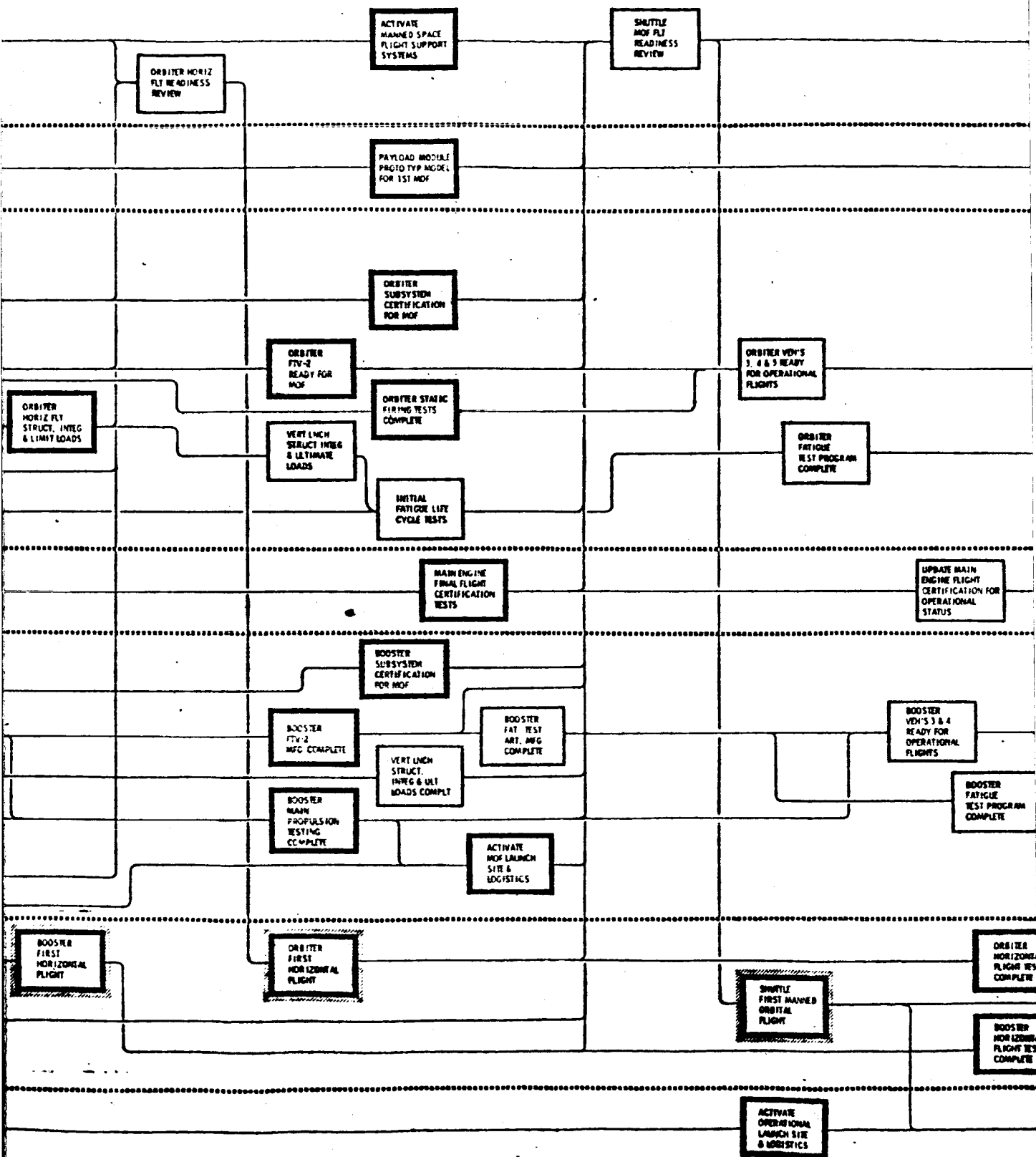
GRATION







4



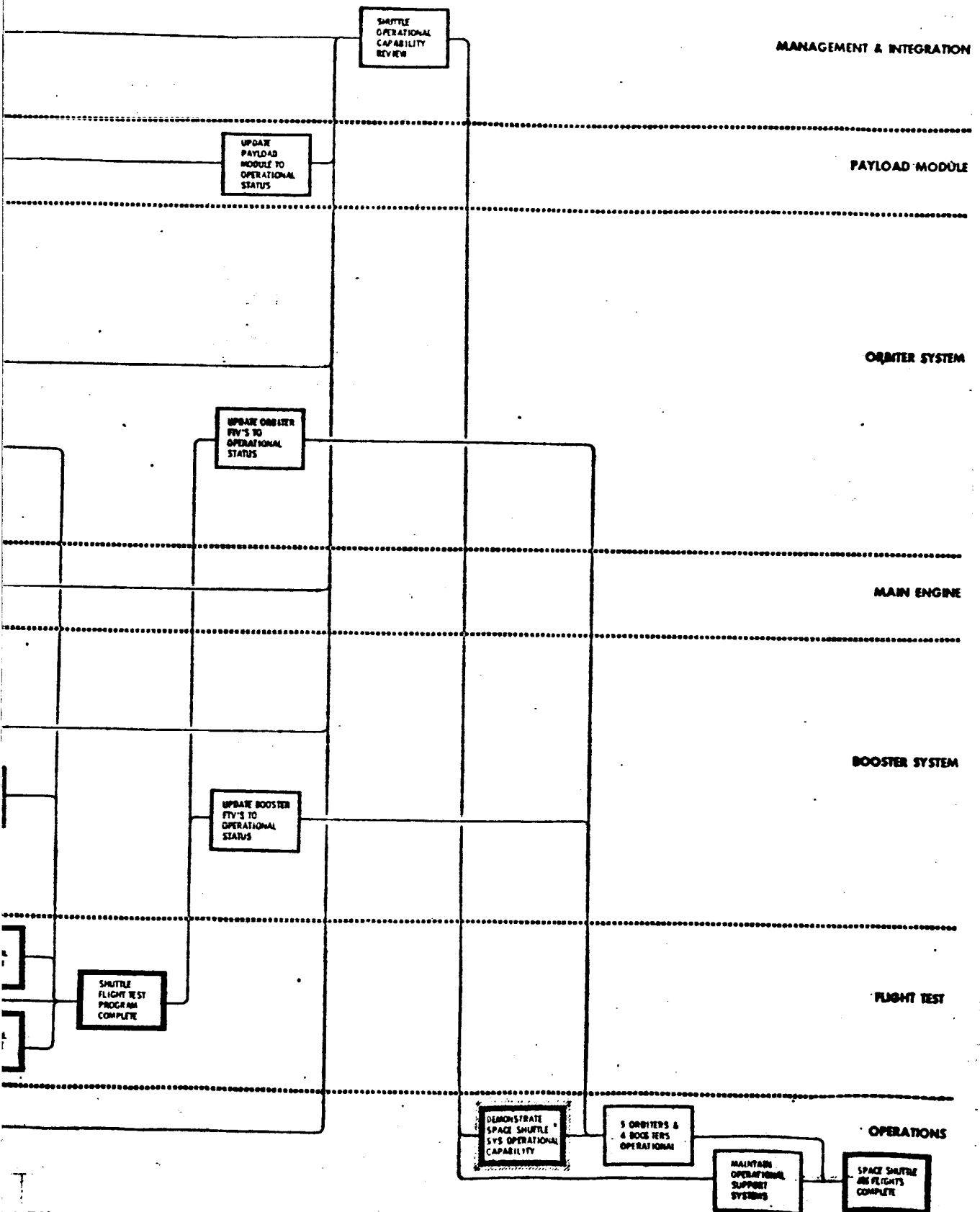


Figure B-2. Space Shuttle System Development Logic (Sheet 2 of 3)

B-7, B-8

SD 71-101

## ORBITER

### SHUTTLE SYSTEM INTERFACE

PHASE C/D GO-AHEAD  
& SHUTTLE SYSTEM  
SPECIFICATION  
ESTABLISHED

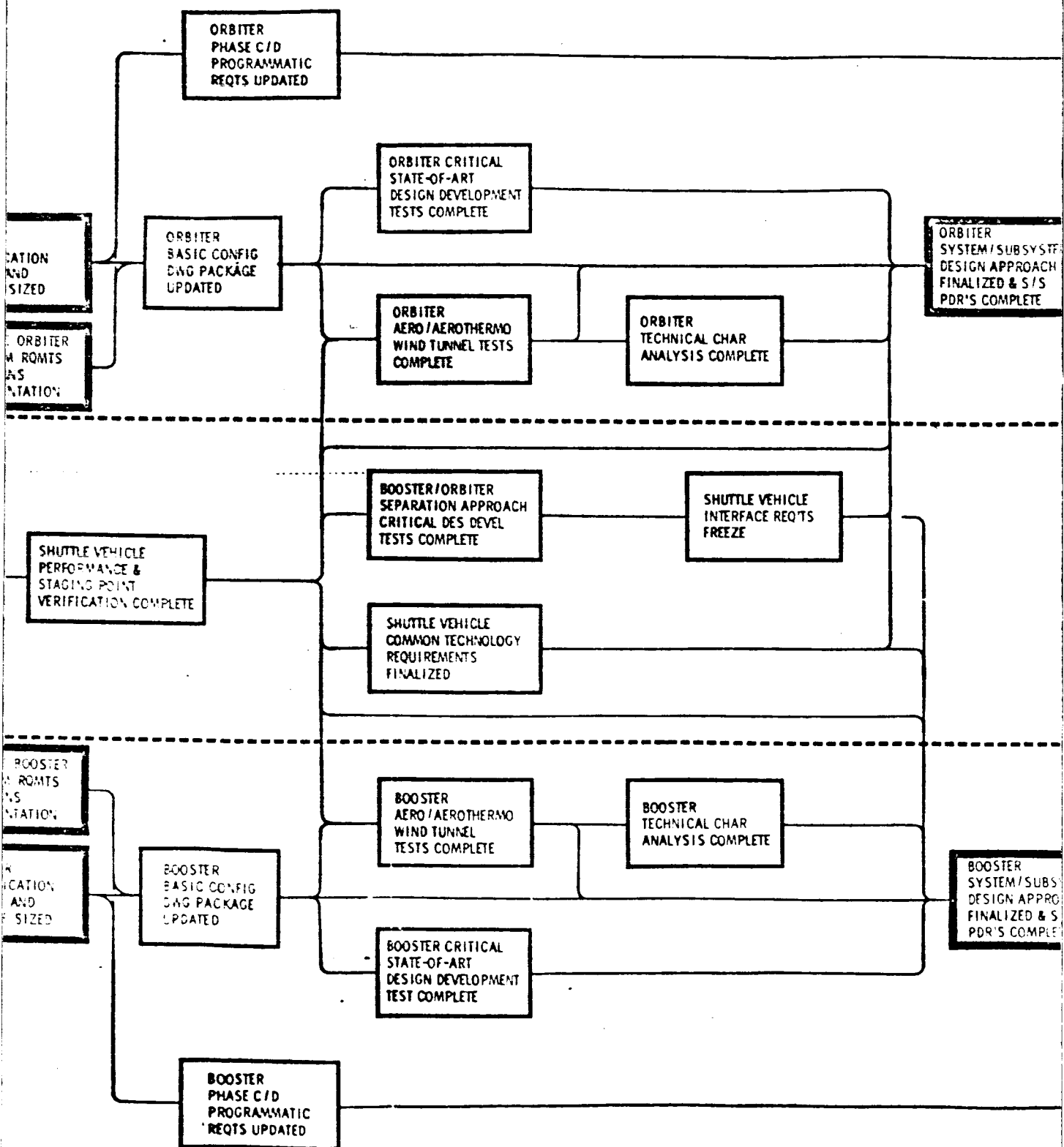
## BOOSTER

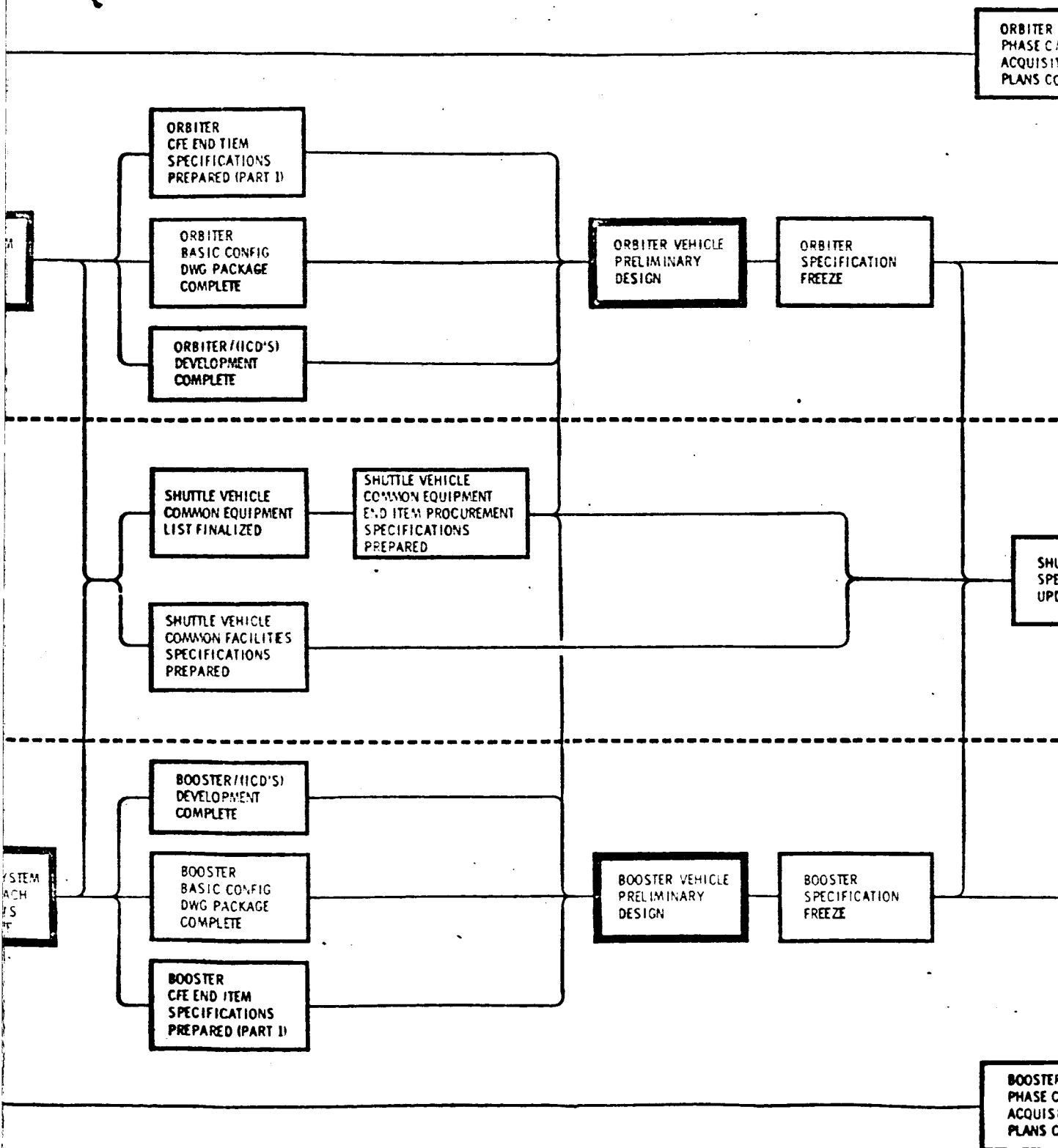
ORBITER  
SPECIFIC  
REVIEW  
VEHICLE

FINALIZE  
PROGRAM  
AND PLAN  
IMPLEMENT

FINALIZE  
PROGRAM  
AND PLAN  
IMPLEMENT

BOOSTER  
SPECIFIC  
REVIEW  
VEHICLE







ORBITER

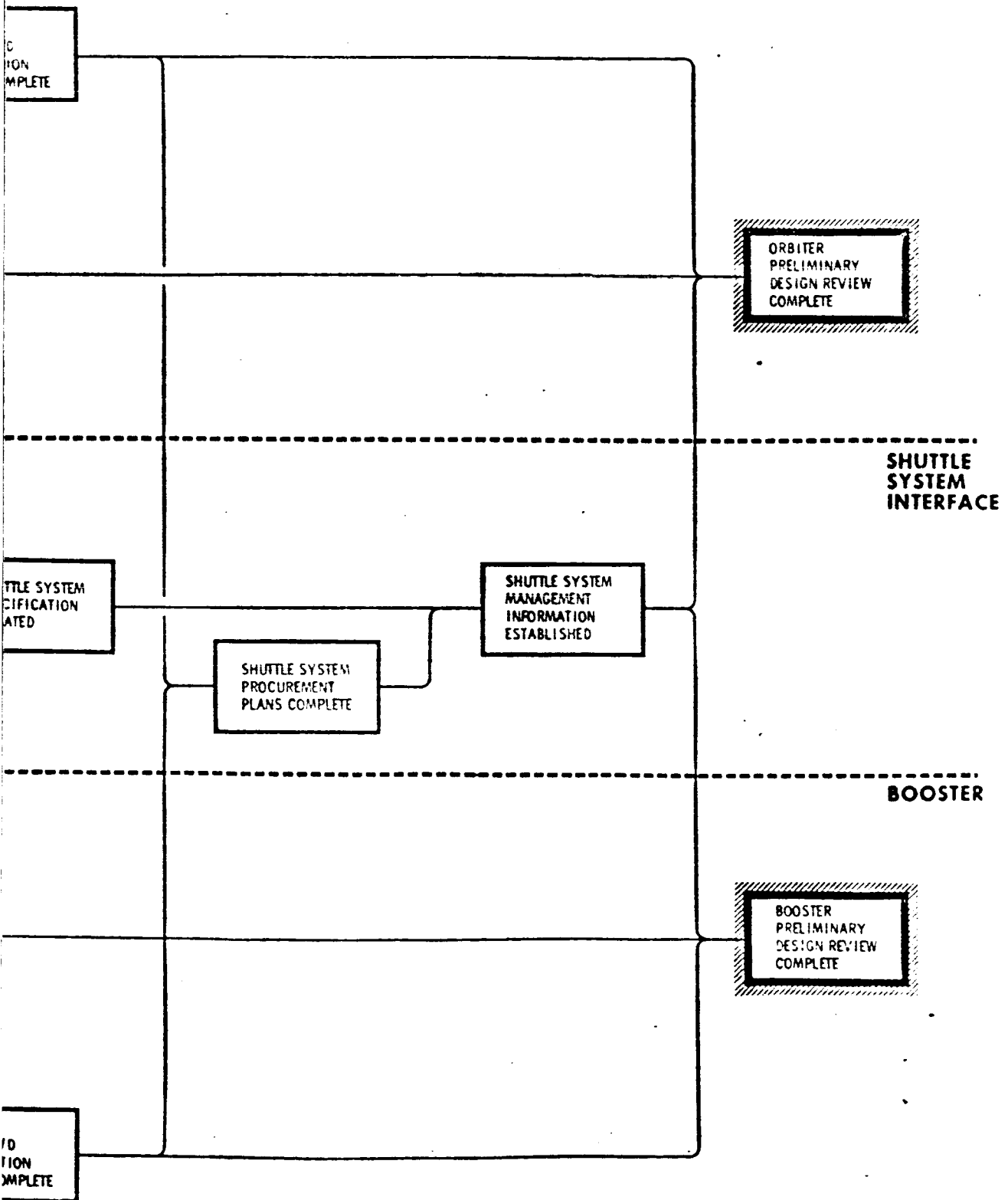


Figure B-2. Space Shuttle System Development Logic (Sheet 3 of 3)

B-9, B-10

SD 71-101

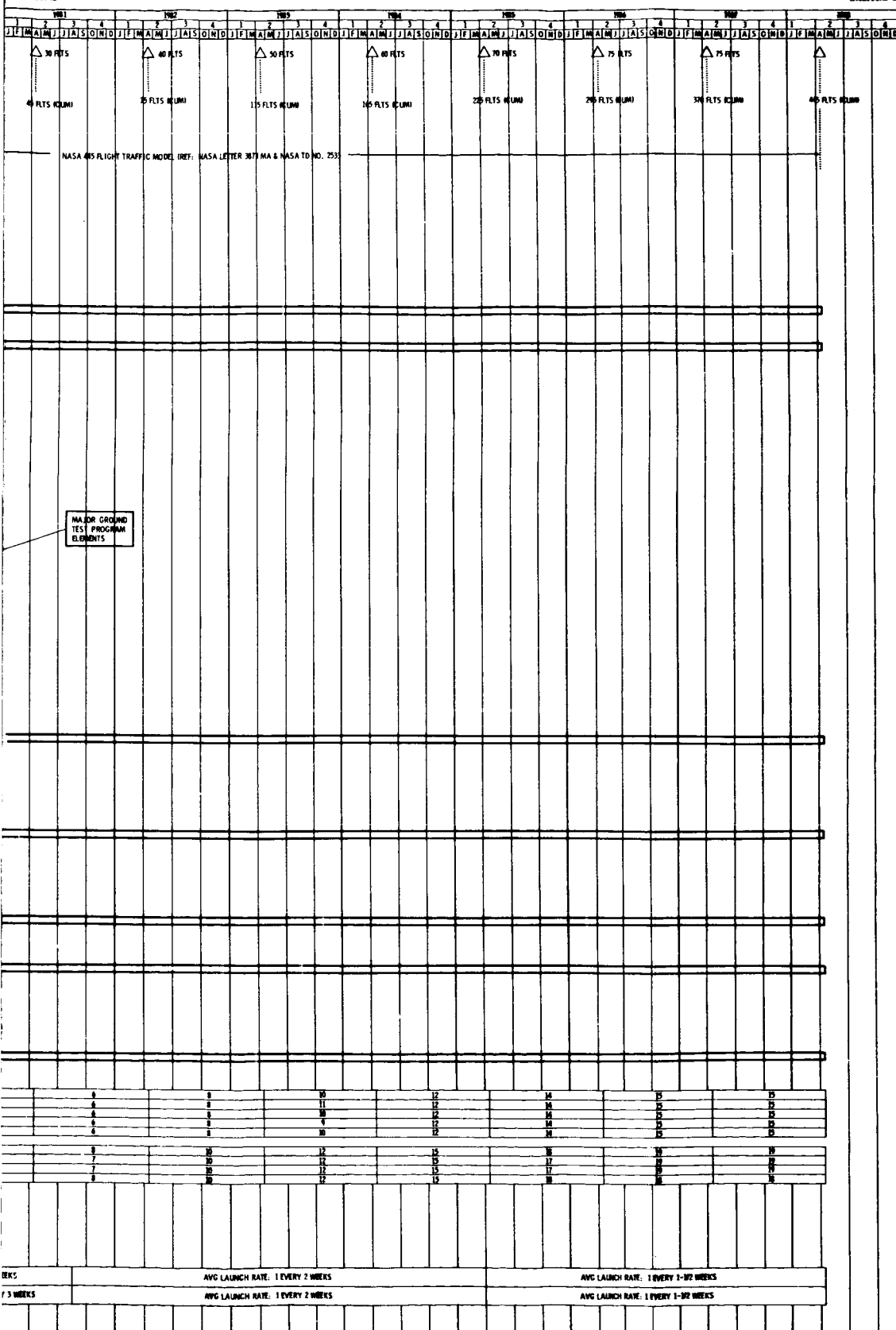
4





3 BASELINE  
SUBMITTAL

ENCLOSURE 10



B. HELLO  
VICE PRESIDENT & GENERAL MANAGER  
SPACE SHUTTLE PROGRAM  
SCA C/D-5-85-01-01 DATED 8-22-71

PREPARED BY D/00  
SCHEDULE DEVELOPMENT & CONTROL

LEGEND	
PDR	PRELIM DESIGN REVIEW
CDR	CRITICAL DESIGN REVIEW
TPS	THERMAL PROTECTION SUBSYSTEM
PCD	POST CHECK OPERATIONS KLOUSE OUT, SHIPPING PREPS ETC
INF C/D	INTEGRATED CHECKOUT
SHIPPING	SHIPPING
ACCEPTANCE / DELIVERY CONTROLLED MILESTONE	ACCEPTANCE / DELIVERY CONTROLLED MILESTONE
STATIC FIRING	STATIC FIRING
MAILED LAUNCH	MAILED LAUNCH
MAIN ENGINE MOCK-UP NEED DATE	MAIN ENGINE MOCK-UP NEED DATE
MAIN ENGINE SIMULATOR NEED DATE	MAIN ENGINE SIMULATOR NEED DATE
FLIGHT ENGINE'S MAIN NEED DATE	FLIGHT ENGINE'S MAIN NEED DATE
MAILED LAUNCH WITH ORBITER NO. 2 & BOOSTER NO. 2	MAILED LAUNCH WITH ORBITER NO. 2 & BOOSTER NO. 2
STATIC FIRE ON ORBITER NO. 2	STATIC FIRE ON ORBITER NO. 2

#### NOTES:

- ORBITER BASELINE CONFIG IS A MAC ON CROSS RANGE-DELTA WING
- BOOSTER BASELINE CONFIG IS A B-9U UFT WING-CANARD
- GROUND RULES & ASSUMPTIONS ARE CONTAINED IN ENCLOSURE 10 TO PROGRAM DIRECTIVE NO. 3043, DATED 5-27-71

#### NASA DIRECTION:

- THE FIRST HORIZ FLIGHT SHALL OCCUR IN JUNE, 1974; THE FIRST MAILED ORBITAL FLIGHT IN APRIL, 1976, & SHUTTLE WILL BE OPERATIONAL IN 1970 - 1971. (REF: NASA TFC 007000A, DATED 2-20-71, TO B. HELLO FROM H. GARTRELL)
- OPERATIONAL FLEET SIZE WILL BE BASED ON THE NASA "TRAFFIC MODEL" PROGRESSIVELY INCREASING YEARLY FLIGHT RATES WHICH SPECIFIES A CAPABILITY TO CONDUCT A TOTAL OF 400 FLIGHTS IN 10 YEARS THROUGH A PROGRESSIVE BUILDUP PROCESS. (REF NASA LETTER 3077MA, DATED 07-05-70, TO B. HELLO FROM R.F. THOMPSON, SUBJECT: CONTACT NASP-1000, SPACE SHUTTLE PROGRAM COST ESTIMATES)

Figure B-3. Space Shuttle Phase C/D Master Program Schedule



compatible with Phase C/D program plans and the Phase C/D WBS. Detailed schedule information is contained in the cost and schedule report, SD 71-107.

The approach to preparation of the master schedule includes:

1. Establishment of ground rules and assumptions
2. Consideration of schedule data from other programs such as Apollo, Skylab, Saturn II, X-15, B-70 and Space Station
3. Application of schedule data from the contractor's hardware programs
4. Extraction of applicable data from technical analyses conducted during the Space Shuttle Program Phase B Definition Study
5. Use of a WBS that identifies the hardware, software, services, and tasks that must be taken into account
6. Determination of the number and purpose of mockups, test elements, test articles, and flight test and operational hardware
7. Determination of sequence and logic of the PDR's and CDR's
8. Preparation of a list of major program milestones arranged chronologically
9. Use of a program management logic that establishes sequence, constraints, and interdependency of activities
10. Analyses of the previous information and translation of the systems and subsystems requirements into development requirements

These factors were used in an iterative process to assure that the time phasing of the design, development, manufacturing, and testing are achievable and compatible with meeting key program milestones (i. e., first horizontal flight, first manned orbital flight, and operational capability).

Each contractor shall prepare a master program schedule for his element for Phases C and D of the program, utilizing the schedule depicted in Figure B-3 as a baseline. Detailed schedule requirements are identified in Section 3.0.



APPENDIX C  
COMMONALITY CANDIDATES



## SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Integrated Avionics

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSFC	Booster/MSFC	
Communications (Cont'd)	VHF/FM transceiver			x					Orbiter only -- on-orbit commands, voice, data and navigation with TDRS. Booster only -- (DFI).
	S-band transmitter			x					
	Booster/orbiter data link	x							
Displays and Controls	Translation controller assy	x							Orbiter only. Structural configuration unique.
	Rotation hand controller assy			x		x			
	Rudder, nose-wheel steering pedal assy								
	CRT displays/electronics	x		x					
	Alphanumeric displays	x							
	Entry control keyboard	x							
	Caution-warning display modules	x							
	Flt cont mode select panel			x					
	Navigation mode select panel			x					
	Throttle control assy			x		x			
Data and control management system (does not include data bus)	Time readout displays								Added modes in orbiter, not in booster. Engine configuration unique.
		x							
	Main storage unit								
	Central processing unit	x							
	I/O bus control unit	x							
	Mass memory unit	x							

# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Integrated Avionics

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSC	
Software	Vehicle; common data base Support program Flight program Flight program verification Support equipment program Support equipment verification  Guidance package	x					TO BE COMPLETED DURING PHASE C/D NEGOTIATION		
		x		x					
				x					
				x					
				x					
<div><div><div>A Develop as a common item</div><div>B Potential common item</div></div><div><div>C Vehicle-unique</div><div>D Government-furnished equipment</div></div><div>E Common (Off the Shelf), no development</div></div>									



## Integrated Avionics

C-5

# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Integrated Avionics

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSFC	
Instrumentation (includes DFI)	Signal-conditioning packages Sensor-conditioning packages Recorders Master timing unit		x				TO BE COMPLETED DURING PHASE C/D NEGOTIATION		Substantial commonality. System design will be unique, but use a large proportion common components.
			x						
			x						
			x						
A Develop as a common item		C Vehicle-unique					E Common (Off the Shelf), no development		
B Potential common item		D Government-furnished equipment							



# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Vehicle Support

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSFC	
Vehicle support subsystem (includes crew provisions, EC/LSS and hydraulics)  EC/LSS sub-system	Cabin press. relief valves O <sub>2</sub> bottles (2 hrs emergency supply) Cabin temperature sensor Temperature transducer Temperature signal amplifier Face mask Regulators Miscellaneous instrumentation	x		x			TO BE COMPLETED DURING PHASE C/D NEGOTIATION		Total subsystem generally does not lend itself to common development. Substantial cost savings possible through common development of selected components.
		x							
		x							
		x							
		x							
		x							
		x							
		x							
		x							
		x							
Electrical power generation subsystem									Installation and power demands are vehicle-unique. However, many components of subsystem and similar orbiter/booster subsystems can be developed as common items.
Legend:									
A Develop as a common item							E Common (Off the Shelf), no development		
B Potential common item							C Vehicle-unique		
							D Government-furnished equipment		

# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Vehicle Support

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSFC	
Fuel cell power plant				x					Orbiter only. Other application such as space station not sufficiently defined to establish commonality.  No requirement on booster for supercritical H <sub>2</sub> or O <sub>2</sub> storage -- orbiter only.
Battery		x							
H <sub>2</sub> super-critical dewar				x					
O <sub>2</sub> super-critical dewar				x					
TO BE COMPLETED DURING PHASE C/D NEGOTIATION									
<div> <div>A Develop as a common item</div> <div>B Potential common item</div> <div>C Vehicle-unique</div> <div>D Government-furnished equipment</div> <div>E Common (Off the Shelf), no development</div> </div>									



# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: \_\_\_\_\_ Vehicle Support

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSFC	
APU subsystem	APU module AC generator Isolation valves Plumbing installation	x x x		x					Unique power levels and installations.
Hydraulic sub-system (includes TVC, aero flight control, landing gear and brake actuator functions)				x					Vehicle unique. Commonality in materials, fittings & bracketry. Installation and power requirements are vehicle unique. However, approximately 80 percent of major components can be developed as common items.
Hydraulic main engine gimbals	Pumps Motor pumps Reservoirs N <sub>2</sub> storage bottles Filters Valves Pressure transducers Temperature transducers Servo actuators Valves	x x x x x x x x	x x x x x x x x						Orbiter only.  Vehicle-unique.
TO BE COMPLETED DURING PHASE C/D NEGOTIATION									
E Common (Off the Shelf), no development									
C Vehicle-unique									
D Government-furnished equipment									
A Develop as a common item									
B Potential common item									



# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Vehicle Support

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSC	
Hydraulic aerodynamic flight control	Servo actuators Control servo assembly Transducers	x		x					
Hydraulic nose and main landing gear and brake	Actuators Valves Accumulators		x	x					
Hydraulic engine deployment	Rotary actuator, motor, gearbox Door actuator Valves		x	x					
							TO BE COMPLETED DURING PHASE C/D NEGOTIATION		
<b>A</b> Develop as a common item <b>B</b> Potential common item		<b>C</b> Vehicle-unique <b>D</b> Government-furnished equipment					<b>E</b> Common (Off the Shelf), no development		





## SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Vehicle Support

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		Commonality Category					Orbiter/MSFC	Booster/MSFC	
		A	B	C	D	E			
Personnel provisions	Not applicable			x			TO BE COMPLETED DURING PHASE C/D NEGOTIATION		Mixture GFE/CFE development. Carriage/attach assys unique.
	Ejection seat and restraints*	x							
	Crew seat and restraints*		x						
	Coveralls	x			x				
	Elec/comm umbilical	x							
	Life vest	x			x				
	Sun glasses	x			x				
	Pen lights	x			x				
	Chronograph and band	x			x				
	Motion sickness bag	x			x				
	Crew survival kit		x		x				
	Crew life raft	x			x				
	Crew escape rope		x						
	Biinstrumentation	x			x				
	Constant wear garment (underwear)		x		x				
	Headset	x			x				
	Pencil	x			x				
	Medical kit(s)		x		x				
	Binoculars		x		x				
	Portable floodlights		x		x				
	Personal preference kit			x					
	Camera, lenses, film, etc. (some)		x		x				
	Press garments & accessories (flight test only)					x			
	O2 masks	x							
	Evacuation reels	x							
	Fire extinguishers		x						
	* Some noncommon components may be required in assembly								
TO BE COMPLETED DURING PHASE C/D NEGOTIATION									
E Common (Off the Shelf), no development									
A Develop as a common item C Vehicle-unique									
B Potential common item D Government-furnished equipment									

# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Propulsion

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSC	
Propulsion (includes main rocket engines, ABES, ACPs and OMS)				x					Wide range of technology involved over the spectrum of engines required with differing requirements between the two vehicles make a totally common development approach unattractive. However, generally compatible with common development of subsystem components -- components approximately 80 percent common.
Main rocket engine subsystem				x					
Main rocket engine subsystem					x				
Propellant tanks and feed line assembly	Not applicable	x							Power heads can be developed as common item; exit nozzle sub-assembly is most significant noncommon item.
	Disconnects Propellant lines, gimbals Propellant tanks LO <sub>2</sub> & LH <sub>2</sub> fill & drain valves LO <sub>2</sub> & LH <sub>2</sub> vent valves LO <sub>2</sub> & LH <sub>2</sub> prevalues He valves Regulator Check Solenoid	x	x	x					Tank volume requirements, line lengths and shape substantially different. Many high-cost valves and components can be developed as common items because of selection of identical line sizes on both vehicles.
TO BE COMPLETED DURING PHASE C/D NEGOTIATION									
E Common (Off the Shelf), no development									
C Vehicle-unique									
D Government-furnished equipment									
A Develop as a common item									
B Potential common item									





C-13

Subsystem	Major Components	Commonality Category				Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	
ACPS Subsystem	Instrumentation	x					TO BE DETERMINED DURING PHASE C/D NEGOTIATION	
	LO <sub>2</sub> and LH <sub>2</sub> point sensors	x						
	POGO suppression	x	x					
	Engine avionics interface	x	x					
	Engine interface	x						
	Engine pressure isolation check valve	x						
	Thrust chamber assembly	x						
	Turbo pump assembly		x					
	GO <sub>2</sub> heat exchanger		x					
	GH <sub>2</sub> heat exchanger		x					
GO <sub>2</sub> accumulator		x						
GH <sub>2</sub> accumulator		x						
Distribution components		x						
Valves		x						
H <sub>2</sub> & O <sub>2</sub> relief								
H <sub>2</sub> & O <sub>2</sub> fill & drain								
H <sub>2</sub> & O <sub>2</sub> pressure regulator								
H <sub>2</sub> & O <sub>2</sub> check								
H <sub>2</sub> & O <sub>2</sub> isolation								

**A** Develop as a common item

**B** Potential common item

**C** Vehicle-unique

**D** Government-furnished equipment

**E** Common (Off the Shelf), no development

# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: PROPULSION

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSFC	Booster/MSFC	
OMS Subsystem	Instrumentation	x							Not required on booster. Unique to orbiter.
	Propulsive/nonpropulsive vent			x					
				x					
	TO BE DETERMINED DURING PHASE C/D NEGOTIATION								
E Common (Off the Shelf), no development									
A Develop as a common item B Potential common item C Vehicle-unique D Government-furnished equipment									



# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Propulsion

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSC	
ABES subsystem	Air-breathing engine assy	x		x					Differing propellant quantities and installation requirements. However, most major assemblies and components can be developed as common items.
	Propellant tank & feed assy								Booster vehicle will have most stringent requirements for thrust uprating and source of greatest change activity.
	Boost pumps								Grossly different tank shapes and volumes for the two vehicles.
	Valves								Shelf-type equipment -- booster requires higher flow, larger pumps or more pumps if commonality with orbiter is to be achieved.
	Fill and drain								High-cost valves will have common development. Shelf-type hardware to be used where applicable.
	Vent relief								A majority of components common. Some unique requirements because of system design difference.
	Isolation								Shelf-type equipment.
	Level control								
	Instrumentation								
	Point sensors	x							
	Fire extinguishing/detection system	x							
	Gaging system		x						
	Engine thrust control		x						
	Starter (engine)		x						
TO BE COMPLETED DURING PHASE C/D NEGOTIATION									
E Common (Off the Shelf), no development									
A Develop as a common item									
B Potential common item									
C Vehicle-unique									
D Government-furnished equipment									

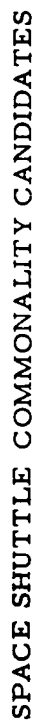




# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Support Equipment

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion	
		A	B	C	D	E	Orbiter/MSFC	Booster/MSFC		
Support equipment	Anthropomorphic dummy	x							TO BE COMPLETED DURING PHASE C/D NEGOTIATION	
	Electric drive	x								
	Gearbox	x								
	Horn and antenna set	x								
	A-C power supply	x								
	Truck-fire	x								
	Truck-safety	x								
	Maintenance transportation - pickup truck	x								
	Kit-rescue equipment	x								
	Crane-mobile	x								
	Cover-ABES intake	x								
	Cover ABES exit	x								
	Pin-landing gear safety	x								
	Weighing system	x								
	Air transport-GSE & LRU	x								
	M & R bus switching unit	x								
	Support console, ground display and control	x								
	Launch control bus switching unit	x								
	Ground bus interface select buffer	x								
	Ground bus control unit	x								
	Ground bus interface	x								
	Vehicle data bus simulator	x								
	Support equipment simulator	x								
	Communications test console	x								
	Rate table	x								
	Nav displace table & console	x								
A Develop as a common item							E Common (Off the Shelf), no development			
B Potential common item							C Vehicle-unique D Government-furnished equipment			

Subsystem Group: Support EquipmentSD 71-101

# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Support Equipment

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSEC	
	Pneumatic test stand	x					TO BE COMPLETED DURING PHASE C/D NEGOTIATION		
	Hydraulic test stand	x							
	JP test stand	x							
	Lube oil servicing unit	x							
	JP servicing unit	x							
	Hydraulic power unit	x							
	Nitrogen panel	x							
	Pressure reduction panel	x							
	Regulation panel	x							
	Nitrogen heat exchanger	x							
	Helium heat exchanger	x							
	LN <sub>2</sub> valve panel	x							
	Nitrogen valve panel	x							
	Helium valve panel	x							
	GN <sub>2</sub> valve panel	x							
	Water test stand	x							
	ABES servicing unit	x							
	Pneumatic starter cart	x							
	Liquid hydrogen catch tank	x							
	Liquid oxygen catch tank	x							
	JP catch tank	x							
	JP tank truck	x							
	Caseous nitrogen trailer	x							
	Nitrogen distribution unit	x							
	Purge control unit	x							
	Sample kit-oxygen	x							
	Sample kit-gases	x							
	Sample kit-fluids	x							
	Lubrication servicing unit	x							
	Oil analyzer-ABES	x							
	Port module leak test unit	x							
	Hydrogen leak detector	x							
E Common (Off the Shelf), no development									
A Develop as a common item		C Vehicle-unique							
B Potential common item		D Government-furnished equipment							

# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Support Equipment

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSEFC	
	Communications/navigation system tester Electrical test load bank Gen purpose digital computer (GDC 6600 class) Manned spaceflight network UIIF communications set Pneumatic distribution unit Pneumatic test set VHF/UIHF test bench L-band, C-band test bench S-band test bench Maintenance test adapter kit IMU test station Core memory extender Analog test station Digital test station Central data bank model DCM test station Electrical load bank Ground data bus system Automatic circuit analyzer Mobile control & display unit He mass spectrometer leak detector KSC flt tests DPI data sta Pyro simulator unit Shorting plug set-ordnance Operational site cable set Electrical test station Final assy test adapter kit Equipment-inspection	x 							



[illegible]



# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Facilities

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSC	
Facilities test	Structural test, component and section level		x						
	Antenna pattern testing		x						
	EC/LS testing		x						
	Crew escape module rocket sled test		x						
	MP's propellant mgt test and cluster firing		x		x				
	MP's component development		x						
	Avionics sys component dev		x						
	Hydraulic sys component dev		x						
	Auxiliary propulsion system component dev		x						
	Power generation system component dev		x						
Development test	ABE'S testing		x						
	Main propulsion system test		x						
	Orbit maneuver system		x						
	Attitude control propulsion system test		x						
	Air-breathing engine sys test		x						
	Power generation subsys test		x						
	Avionics subsystem		x						
	Integration test		x						
	Structural test		x						
	Ground vibration test		x						
Thermal vacuum test		x							
Hydraulic system test		x							
Flight technology		x							
Antenna pattern testing		x							
A Develop as a common item									E Common (Off the Shelf), no development
B Potential common item									

# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Facilities

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSFC	Booster/MSFC	
	Crew escape system test Life systems support test Human factors testing		x						
			x						
			x						
<div> <div> <div>A Develop as a common item</div> <div>B Potential common item</div> </div> <div> <div>C Vehicle-unique</div> <div>D Government-furnished equipment</div> </div> <div>E Common (Off the Shelf), no development</div> </div>									



# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Training

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSC	Booster/MSFC	
Training equipment	Proficiency training aircraft	x			x				The simulator which handles both the booster and orbiter is procured as one item under one performance specification. There are elements within the device which are unique, however, such as the cockpits.  The trainer, for purposes of economy, is constructed to handle both booster and orbiter activities. Many elements of the training, however, are unique to the booster or orbiter.  Preliminary training for orbiter and booster can be given in common, particularly the parts involving principles of operation. Divergence occurs in the specific differences in application, size, location, interface, etc.
	Full mission simulator	x							
	Procedures trainer								
	Ingress-egress trainer	x							
	"G" trainers	x							
	Mfg. spec. processes trainers		x						
	Environ & life support systems trainers		x						
	Separation system trainer								
	MPS trainer			x					
	APU trainer		x						
	ABES trainer		x						
	ABES deployment trainer			x					
	Landing gear trainer			x					
	ACPS trainer			x					
	TVC trainer		x						
	Aero surface act. trainer			x					
	TPS trainer		x						
	Display & control trainer		x						
	DCM trainer		x						
COFI trainer		x							
GN&C trainer		x							
Pyrotechnic device trainer		x							
A Develop as a common item		C Vehicle-unique					E Common (Off the Shelf), no development		
B Potential common item		D Government-furnished equipment							



# SPACE SHUTTLE COMMONALITY CANDIDATES

Subsystem Group: Training

Subsystem	Major Components	Commonality Category					Development Responsibility (Contractor/Center)		Discussion
		A	B	C	D	E	Orbiter/MSFC	Booster/MSFC	
Training categories	Flight crew		x						Training facilities such as classrooms, simulation and trainer areas, teaching aids such as projectors, TV, screens, etc., are common across the board.
	Manufacturing processes		x						
Facilities	On-the-job training		x						
	Certification training		x						
	Maintenance training		x						
	Safety training		x						
	Familiarization training		x						
	Operations and procedures		x						
	Training facilities at KSC		x						
	Training facilities at Michoud		x						
							TO BE DETERMINED DURING PHASE C/D NEGOTIATION		
A Develop as a common item		E Common (Off the Shelf), no development							
B Potential common item		C Vehicle-unique							
		D Government-furnished equipment							





RELIABILITY PROGRAM REQUIREMENTS  
FOR  
SPACE SHUTTLE

PROGRAM MANAGEMENT PLAN

APPENDIX D

(ATS/360 41005010005:6)

SPACE DIVISION  
NORTH AMERICAN ROCKWELL



## APPENDIX D

### SHUTTLE RELIABILITY PROGRAM REQUIREMENTS

#### PHASE C/D

The following material is an accumulation of the Reliability Requirements to be implemented on the Space Shuttle Program. NASA document NHB-5300.4 1A was used as a baseline in the definition of these required activities. Implementation modes to ensure the acceptable achievement of each requirement are provided in Shuttle Reliability Procedures. For effective management control, these reliability requirements have grouped into nine basic tasks. These are:

1. Reliability Program Management
2. Design Specifications
3. Reliability Evaluation
4. Failure Mode Effect Analysis and Single Failure Point Summary
5. Maintainability
6. Design Review
7. Problem Reporting and Corrective Action
8. EEE Parts Program, and Materials Program
9. Testing

Note: Entries in the requirement matrix which were not specified in NHB5300.4-1A, are defined in the attached dictionary of requirement descriptions.



## Task 1 - Reliability Program Management

The Reliability Program Management effort shall consist of a planned organized approach to the establishment of reliability requirements, implementation activities, and program controls which will ensure the accomplishment of reliability program tasks and cost-effective application of the reliability disciplines. The requirements for the reliability management task are indicated below:

Notes: A. Right hand columns designated as follows:

1. Baseline: NHB5300.4 1A
2. Air Vehicle Hardware Requirements
3. Mission Essential GSE
4. Non-Mission Essential GSE

### 1A201-1

DEVELOP AND IMPLEMENT RELIABILITY PLAN	1	2	3	4
DESCRIBE ORGANIZATIONAL RESPONSIBILITIES AND FUNCTIONS	X	X	X	X
BY TASK, IDENTIFY DUTIES OF PARTICIPATING ORGANIZATION ELEMENTS	X	X	X	X
DEFINE INTERFACES, AND RESPONSIBILITIES WITH OTHER ORGANIZATIONAL ELEMENTS, BY TASK	X	X	X	X
IDENTIFY ORGANIZATIONAL RELATIONSHIP BETWEEN RELIABILITY MANAGEMENT AND OTHER PROGRAM ELEMENTS PERFORMING RELIABILITY TASKS	X	X	X	X
EACH RELIABILITY REQUIREMENT SHALL BE DESCRIBED NARRATIVELY AND HAVE AN ATTENDANT PLAN OF EXECUTION	X	X	X	
MAINTAIN A MATRIX SHOWING IMPLEMENTATION RESPONSIBILITY, APPROVAL AND REVIEW, AND DOCUMENTATION OF EACH REQUIREMENT	X	X	X	X
DEFINE AUTHORITY OF RELIABILITY MANAGEMENT TO CONTROL/MONITOR EACH TASK	X	X	X	X
IDENTIFY THOSE CRITICAL HARDWARE/SOFTWARE FROM SUBCONTRACTORS THAT REQUIRE RELIABILITY PROGRAMS	X	X	X	X
IDENTIFY PLANNED PROGRAM ELEMENTS TO UTILIZE EXISTING PROCEDURES WITH SCHEDULE FOR AND A DESCRIPTION OF PROPOSED CHANGES	X	X	X	
LIST DEVICES, COMPONENTS, AND SOFTWARE ITEM TO BE PROVIDED BY SUPPLIERS NOT UTILIZING A FORMAL RELIABILITY PROGRAM PLAN	X	X	X	
EVALUATE PAST TECHNICAL PERFORMANCE OF EACH POTENTIAL SOURCE OF SUPPLY		X	X	X

### 1A201-3

PROVIDE RELIABILITY PLANNING FOR SITES	1	2	3	4
GENERATE SELF-CONTAINED SITE PLAN FOR LAUNCH AND TEST SITE RELIABILITY PROGRAMS	X			
USE LAUNCH SITE RELIABILITY PLAN, ONLY		X	X	
CONDITIONS PECULIAR TO A TEST/MANUFACTURING SITE SHALL BE INCLUDED AS SEPARATE PARTIAL PLANS IN THE RELIABILITY PROGRAM PLAN	X	X	X	X



1A202-1				
IMPLEMENT RELIABILITY PROGRAM CONTROL	1	2	3	4
IDENTIFY ORGANIZATIONAL EXECUTORS OF EACH RELIABILITY TASK	X	X	X	X
DEFINE TIME-PHASING AND MILESTONES FOR EACH TASK	X	X	X	
PROVIDE AND MAINTAIN ACCOUNTING FOR COMPLETED AND PROJECTED EXPENDITURES FOR EACH TASK	X	X	X	
1A202-2				
CONDUCT RELIABILITY PROGRAM REVIEWS	1	2	3	4
CONDUCT PERIODIC REVIEWS OF RELIABILITY PROGRAM AND REPORT IDENTIFIED PROBLEM AREAS TO THE NASA	X	X	X	
CONDUCT PERIODIC REVIEWS OF SUPPLIER RELIABILITY PROGRAMS	X	X	X	
DEFINE FORMAT FOR REPORTING REVIEW RESULTS WITH SCHEDULE FOR THE REVIEWS/AUDITS	X			
MAKE PROVISION FOR NASA PARTICIPATION IN SELECTED REVIEWS	X	X	X	
1A203-1				
PERIODICALLY ADVISE NASA OF RELIABILITY PROGRAM STATUS	1	2	3	4
PROVIDE PERIODIC PROGRESS REPORTS ON RELIABILITY PROGRAM	X			
A REPORT STATUS OF TASK ACCOMPLISHMENTS AND MILESTONES	X			
B RECOMMEND CORRECTIVE ACTIONS FOR IDENTIFIED PROBLEM AREAS	X			
C IDENTIFY REVISIONS IN SCHEDULE	X			
D IDENTIFY PROGRAM DECISIONS/ACTIONS AFFECTING RELIABILITY ASSESS THEIR IMPACT				
E ADVISE OF ANTICIPATED PROGRAM SLIPPAGES AND THEIR EFFECT	X			
PREPARE FORMAL REPORTS ON SUPPLIERS RELIABILITY PROGRAM STATUS	X			
1A203-2				
HOLD JOINT CONTRACTOR/NASA MEETINGS	X	X	X	
CONDUCT PERIODIC QUARTERLY CONTRACTOR/NASA PROGRAM MANAGEMENT REVIEWS		X	X	X
A REPORT STATUS OF TASK ACCOMPLISHMENTS AND MILESTONES		X	X	X
B RECOMMEND CORRECTIVE ACTIONS FOR IDENTIFIED PROBLEM AREAS		X	X	X
C IDENTIFY REVISIONS IN SCHEDULE		X	X	
D IDENTIFY PROGRAM DECISIONS/ACTIONS AFFECTING RELIABILITY ASSESS THEIR IMPACT		X	X	X
E ADVISE OF ANTICIPATED RELIABILITY PROGRAM SLIPPAGE/EFFECT		X	X	X
AUGMENT STATUSING BY INFORMAL DAY-TO-DAY REPORTING	X	X	X	
1A203-3				
PROVIDE RELIABILITY PROGRAM CONTROL REPORTS	1	2	3	4
GENERATE RESOURCES PLANNED VS. RESOURCES EXPENDED DATA	X	X	X	X
PROVIDE RESOURCE PROJECTIONS FOR SUCCEEDING MILESTONE INTERVALS	X	X	X	X
IDENTIFY RESOURCES EXPENDED BY OTHER ORGANIZATIONS IN SUPPORT OF RELIABILITY TASKS	X			
1A204				
PROVIDE RELIABILITY TRAINING FOR PERSONNEL USED IN PROGRAM EFFORT	1	2	3	4
PROVIDE TRAINING IN TASK-ASSOCIATED NEW TECHNOLOGIES	X	X	X	
PROVIDE MOTIVATIONAL INDOCTRINATION PROGRAMS	X	X	X	
IDENTIFY TRAINING REQUIREMENTS IN THE RELIABILITY PROGRAM PLAN	X	X	X	
1A205-1				
CONTROL RELIABILITY OF SYSTEM ELEMENTS OBTAINED FROM SUBCONTRACTORS	1	2	3	4
ASSURE ADEQUACY OF RELIABILITY CONTROLS FOR ALL TIERS	X	X	X	X



1A205-2	
PROVIDE CONTROL OF SUPPLIERS RELIABILITY PROGRAMS PER APPENDIX F	1 2 3 4
IDENTIFY THOSE SUPPLIERS REQUIRING RELIABILITY PROGRAMS	X X X X
PROVIDE APPROPRIATE CONTRACTUAL/PROCUREMENT INPUTS TO ENSURE	
CONTROL OF SUPPLIER/SUBCONTRACTOR RELIABILITY PROGRAM	X X X
MAKE PROVISIONS FOR RELIABILITY PROGRAM REVIEW BY THE NASA FOR	
ALL PROCURED HARDWARE/SOFTWARE	X X X
1A205-3	
IDENTIFY DATA AND DOCUMENTATION REQUIREMENTS FOR THOSE SUPPLIERS	
WHO ARE NOT REQUIRED TO HAVE RELIABILITY PROGRAMS	X X X X
DEVELOP AND PROVIDE GUIDELINES FOR TASK IMPLEMENTATION TO ENSURE	
COMMONALITY IN APPROACH BETWEEN CONTRACTOR AND SUBCONTRACTORS	X X X
1A206	
INTEGRATE RELIABILITY ACTIVITIES ASSOCIATED WITH GFP HARDWARE	1 2 3 4
OBTAIN ADEQUATE RELIABILITY DATA ON GFP FROM THE PROCURING	
NASA ORGANIZATION	X X X
INTEGRATE GFP DATA, PROBLEM REPORTING, EVALUATION TESTING INTO	
THE SHUTTLE RELIABILITY TASKS	X X X
FORMALLY ADVISE NASA OF INCONSISTENCIES IN RELIABILITY OF	
SYSTEM AND GFP	X X X
PROVIDE FORMAL ADVICE TO THE NASA REGARDING ANY INCOMPATIBILITY	
BETWEEN GFP AND SHUTTLE SYSTEM	X X
INTEGRATE OFF THE SHELF HARDWARE INTO SHUTTLE VEHICLE	1 2 3 4
PROVIDE A SYSTEM FOR ASSURING THE INTEGRITY OF OFF-THE-SHELF	
HARDWARE	X X



## Task 2 - Design Specifications

The contractor shall generate specifications to provide control of desired hardware/software characteristics and a consistent recorded baseline for guiding the shuttle design through the program. Details of the specification requirements are listed with an indicated program applicability.

Notes: A. Right Hand Columns designated as follows:

1. Baseline: NHB5300.4 1A
2. Air Vehicle Hardware Requirements
3. Mission Essential GSE
4. Non-Mission Essential GSE

1A301-1				
SPECIFICATION OF RELIABILITY REQUIREMENTS IN DESIGN DOCUMENTATION	1	2	3	4
ASSURE ADEQUATE SPECIFICATIONS FOR EACH ITEM AT SYSTEM, SUBSYSTEM, COMPONENT AND PART LEVEL		X	X	X
DEFINE FUNCTIONAL AND PHYSICAL REQUIREMENTS OF ITEM ENVELOPE		X		
ASSURE THE ENVIRONMENTAL REQUIREMENTS ARE SPECIFIED ADEQUATELY		X	X	X
IDENTIFY TEST REQUIREMENTS AFFECTING RELIABILITY INCLUDING QUANTITIES, OVERSTRESS, ETC.		X	X	X
ASSURE DEMONSTRATION OF SAFETY MARGINS AND DERATING FACTORS		X	X	X
ASSURE IDENTIFICATION OF PHYSICAL PARAMETERS AND CONSTRAINTS		X	X	X
ASSURE DEFINITION OF TEST SETUPS AND CONDITIONS			X	X
ASSURE INSPECTION, ACCEPTANCE/REJECTION CRITERIA ARE DEFINED			X	X
SPECIFY APPORTIONED RELIABILITY GOAL		X		
ENSURE USE OF APPROVED MATERIALS AND PARTS			X	X
REQUIRE APPLICATION OF APPROVED DESIGN, PROCESS, AND FABRICATION PRACTICES			X	X
SPECIFY RELIABILITY REQUIREMENTS AND ASSURE THEIR COMPATIBILITY WITH INTERFACING SUBSYSTEM/PROGRAM ELEMENTS		X	X	X
1A301-2				
PROVIDE RELIABILITY SUPPORT	1	2	3	4
RELIABILITY PERFORM INDEPENDANT REVIEW TO ENSURE APPROPRIATE COVERAGE, CONSISTENCY, AND COMPLETENESS FOR RELIABILITY ASPECTS		X	X	X
ASSURE DEFINITION OF TRACEABILITY, PACKAGING, HANDLING REQUIREMENTS		X	X	X
1A301-3				
SPECIFICATION REVISION	1	2	3	4
REQUIRE SPECIFICATION REVISION WHEN FUNCTIONALLY OUT-OF-DATE OR DEFICIENT		X	X	X
CONDUCT RELIABILITY REVIEW OF SPECIFICATION REVISIONS		X	X	X



### Task 3 - Reliability Evaluation

Reliability analyses consist of those quantitative and qualitative evaluations used to measure conformity of a product to reliability objectives. Elements of this requirement are listed below.

Notes: A. Right hand columns designated as follows:

1. Baseline: NHR5300.4 1A
2. Air Vehicle Hardware Requirements
3. Mission Essential GSE
4. Non-Mission Essential GSE

#### 1A302-1

PERFORM NUMERICAL RELIABILITY ANALYSES ON SHUTTLE SYSTEM DESIGNS	1	2	3	4
ESTABLISH SYSTEM RELIABILITY GOALS	X			
APPORTION GOALS TO SUBSYSTEM LEVEL	X			
APPORTION GOALS TO COMPONENT LEVEL	X			
DEVELOP PREDICTION MODELS	X			
USE PREDICTIONS FOR PROBABILITY OF OCCURRENCE DEFINITION FMEA	X			
USE PREDICTIONS TO IDENTIFY POTENTIAL RELIABILITY PROBLEM AREAS	X			
UTILIZE PREDICTIONS FOR MISSION PLANNING, TEST AND EVALUATION PROGRAM PLANNING	X			
USE PREDICTIONS FOR MAINTENANCE/LOGISTICS PLANNING	X			
UTILIZE PREDICTIONS AS A TRADE STUDY COMPARISON TOOL FOR SIMILAR HARDWARE CONFIGURATIONS	X	X	X	
INPUT APPORTIONED RELIABILITY GOALS TO PROCUREMENT DOCUMENTATION	X			
PERFORM RELIABILITY TESTING TO DEMONSTRATE PREDICTED RELIABILITY LEVELS	X			
USE PREDICTIONS AS A TOOL IN SELECTING REQUIRED REDUNDANCE LEVELS	X	X	X	

#### 1A302-2

PROVIDE FUNCTIONAL BLOCK DIAGRAMS	1	2	3	4
PROVIDE FUNCTIONAL/EQUIPMENT BLOCK DIAGRAMS TO COMPONENT LEVEL	X			
EACH BLOCK SHALL INDICATE PREDICTED RELIABILITY AND APPORTIONED GOAL	X			
UPDATE BLOCK DIAGRAMS	X			



## Task 1A303 - Failure Mode Effect and Criticality Analysis

The failure mode, effect and criticality analysis is a systematic design evaluation, performed in concert with configuration selection efforts, which serves to optimize the subsystem design by identifying potential problem areas due to failures. For each mode of failure, pertinent data are generated and documented to allow the timely implementation of preventative/curative measures.

Notes: A. Right Hand Columns designated as follows:

1. Baseline: NHB5300.4 1A
2. Air Vehicle Hardware Requirements
3. Mission Essential GSE
4. Non-Mission Essential GSE

### 1A303-1

IMPLEMENT THE SHUTTLE FMEA ACTIVITY	1	2	3	4
CATEGORIZE FAILURE MODES BY CRITICALITY BASED ON FAILURE EFFECT	X	X	X	
IDENTIFY PRIMARY CAUSES OF FAILURE MODES	X	X	X	
PROVIDE ESTIMATED TIME TO EFFECT FOR ALL IDENTIFIED MODES		X	X	
INDICATE DETECTABILITY OF FAILURE MODES	X	X	X	
IDENTIFY ALL POTENTIAL HAZARDS	X	X	X	X
IDENTIFY THE NEED FOR REDUNDANT FEATURES OF EQUIPMENT	X	X	X	X
INPUT MISSION SUPPORT/OPERATIONAL DOCUMENTATION	X	X	X	
EVALUATE FAILURE EFFECT ON PERSONNEL/MISSION/SUBSYSTEM/VEHICLE	X	X	X	
IDENTIFY UNIQUE CERTIFICATION REQUIREMENTS FOR FAILURE MODE	X	X	X	
INPUT PART APPLICATION/DERATING REVIEWS	X	X		
USE FMEA TO IDENTIFY TIME/CYCLE OR AGE SENSITIVE COMPONENTS	X	X	X	
ASSESS PROBABILITY OF FAILURE OCCURRENCE	X			
COORDINATE FMEAS WITH ASSOCIATED EFFORTS	X	X	X	
IDENTIFY CRITICAL ITEMS FOR CONFIGURATION CONTROL/TRACEABILITY	X	X	X	
SUPPORT RELIABILITY MODELS AND PREDICTIONS	X			
IDENTIFY MANDATORY INSPECTION POINTS	X	X	X	
ASSURE TEST PROGRAM IS RESPONSIVE TO KNOWN OR SUSPECTED FAILURE MODES	X	X	X	
GENERATE SINGLE FAILURE POINT SUMMARIES	1	2	3	4
DOCUMENT S F P SUMMARY FOR CRITICALITY I HARDWARE	X	X	X	
DOCUMENT S F P SUMMARY FOR CRITICALITY II HARDWARE	X	X	X	
MAINTAIN REAL-TIME VISIBILITY AND CONTROL OF S F P	X	X	X	

### 1A303-2

PERFORM FMEA ON SPACE SHUTTLE HARDWARE	1	2	3	4
PERFORM FMEA AT THE COMPONENT LEVEL	X			
PERFORM FMEA AT LEVEL INDICATED BY SIGNIFICANCE OF FUNCTION		X	X	

### 1A303-3

GENERATE LOGIC DIAGRAMS	1	2	3	4
DEVELOP COMPONENT-LEVEL FUNCTIONAL LOGIC DIAGRAMS	X			
CREATE LOGIC ONLY AS REQUIRED TO SUPPORT INTERPRETATION OF FMEA		X	X	
UPDATE LOGIC DIAGRAMS PERIODICALLY	X	X	X	



## Task 5 - Maintainability/Elimination of Human-Induced Failures

The maintainability effort shall consider those features of the configuration requiring preventative/curative measures to preclude operational difficulties due to failure, wear-out and exceeding useful hardware life. Requirements of this task are listed below:

Notes: A. Right Hand Columns designated as follows:

1. Baseline: NHB5300.4 1A
2. Air Vehicle Hardware Requirements
3. Mission Essential GSE
4. Non-Mission Essential GSE

### 1A304-1

#### PROVIDE SYSTEM MAINTAINABILITY

1 2 3 4

MINIMIZE POTENTIAL SOURCES OF HUMAN INDUCED FAILURES IN  
GROUND SUPPORT AND OPERATIONS, AS WELL AS, MISSION OPERATIONS

X X X

### 1A304-2

#### PERFORM MAINTENANCE PLANNING ACTIVITIES

1 2 3 4

IDENTIFY FAILURE MODES/SYMPTOMS FOR COMPONENT FAILURES

X X X

SUPPORT MAINTENANCE PLAN BY PREDICTING FAILURE/REMOVAL RATES

X

ESTABLISH ANTICIPATED REMOVAL RATES BASED ON USE/TEST DATA

X X

PREDICT REMOVAL RATES FOR THAT HARDWARE HAVING NO USE HISTORY

X X

IDENTIFY AGE-SENSITIVE MATERIALS

X X X

IDENTIFY TIME/CYCLE LIMITED HARDWARE

X X X

HARDWARE

X X X

SUPPORT THE DEFINITION OF LRU SIZING AND REPLACEMENT LEVEL

X

INPUT TRAINING/INSTRUCTIONAL MATERIAL REGARDING FAILURE MODES

THAT RESULT IN HAZARDOUS CONDITIONS

X X X X

REVIEW MAINTAINABILITY CONTROLS AND DOCUMENTATION FOR ADEQUACY

X X X

CLOSELY COORDINATE RELIABILITY/MAINTAINABILITY TASKS TO OPTIMIZE

RELIABILITY/MAINTAINABILITY TRADE-OFF

X X



## Task 6 - Design Review

Designs shall be reviewed to ensure selection of design solutions that are compatible with program objectives. Requirements are listed below:

Notes: A. Right Hand Columns Designated as follows:

1. Baseline: NHB5300.4 1A
2. Air Vehicle Hardware Requirements
3. Mission Essential GSE
4. Non-Mission Essential GSE

### 1A305-1

PERFORM DESIGN REVIEWS	1	2	3	4
EVALUATE DESIGNS AT THE PART LEVEL, WHERE BENEFICIAL		X		
EVALUATE DESIGNS AT THE COMPONENT LEVEL, WHERE BENEFICIAL	X	X		
EVALUATE DESIGNS AT THE SUBSYSTEM LEVEL	X	X	X	X
EVALUATE DESIGNS AT THE SYSTEM LEVEL	X	X	X	X
EVALUATE CHANGES IN PROCESS AND FABRICATION PROCEDURES		X	X	
ASSESS CONFIGURATION CHARACTERISTICS AND ALTERNATE TECHNICAL OPTIONS	1	2	3	4
REVIEW SINGLE FAILURE POINTS	X	X	X	
EVALUATE ACCEPTABILITY OF CRITICAL COMPONENTS, PARTS AND MATERIALS		X	X	X
ASSURE THE ESTABLISHMENT OF MARGINS OF SAFETY AND PROPER DERATING	X	X	X	
ASSESS POTENTIAL DEVELOPMENT PROBLEM AREAS		X	X	X
REVIEW ADHERENCE TO APPROVED DESIGN PRACTICES AND STANDARDS		X	X	X
REVIEW ADEQUACY OF SPECIFICATIONS AND OTHER CONTROL DOCUMENTATION	X	X	X	
IDENTIFY POTENTIAL LOGISTICS/SPARING PROBLEM AREAS		X	X	X
ASSESS TESTABILITY OF PROPOSED CONFIGURATIONS	X	X	X	X
EVALUATE MAINTAINABILITY OF CONFIGURATION CANDIDATES		X	X	
ASSURE SELECTED CONFIGURATION IS COMPATIBLE WITH ESTABLISHED RELIABILITY REQUIREMENTS			X	X
REVIEW CONFIGURATION CERTIFICATION/QUALIFICATION STATUS		X	X	
PROVIDE DESIGN REVIEW DOCUMENTATION/REPORTS	1	2	3	4
PROVIDE DESIGN REVIEW INPUT PACKAGES	X			
GENERATE DESIGN REVIEW MEETING MINUTES	X			
PROVIDE SCHEDULE FOR PROGRAM DESIGN REVIEWS	X	X	X	
DOCUMENT REVIEW RESULTS IN DESIGN REVIEW REPORTS	X	X	X	
MINIMIZE POTENTIAL SOURCES OF HUMAN-INDUCED FAILURES IN DESIGNS	X	X	X	X
RELIABILITY FOLLOW-UP ACTION ITEMS TO ENSURE ADEQUATE COMPLETION	X	X	X	
ASSURE INTERORGANIZATIONAL PARTICIPATION QA, RELIABILITY, DESIGN, NASA, MANUFACTURING, PARTS, ETC.		X	X	X
PERFORM SUPPLIER DESIGN REVIEW	1	2	3	4
PROVIDE A PROGRAM WITH ELEMENTS DEFINED IN PARA. 1A305-1	X	X	X	
RELIABILITY PARTICIPATE, AS REQUIRED, IN SUPPLIER DESIGN REVIEWS	X	X		
PERFORM REVIEW OF ENGINEERING CHANGES	1	2	3	4
RELIABILITY ASSURE PROPER ASSESSMENT OF DESIGN MODIFICATIONS	X	X		
RELIABILITY MEMBERSHIP ON CHANGE CONTROL BOARD	X	X		
DESCRIBE REVIEW PROGRAM IN RELIABILITY PROGRAM PLAN	X	X	X	X



## Task 7 - Problem/Failure Reporting and Correction

A closed-loop system of failure/problem reporting, investigation/analysis, and corrective action will be implemented on the shuttle program. This effort shall be so organized and implemented as to provide appropriate program emphasis on problem resolution in a manner consistent with shuttle program objectives.

Notes: A. Right Hand Columns designated as follows:

1. Baseline: NHR5300.4 1A
2. Air Vehicle Hardware Requirements
3. Mission Essential GSE
4. Non-Mission Essential GSE

1A306-1

IMPLEMENT A HARDWARE PROBLEM/FAILURE REPORTING SYSTEM	1	2	3	4
REPORT FAILURES ON FLIGHT CONFIGURED HARDWARE	X	X		
REPORT FAILURES ON GROUND EQUIPMENT DIRECTLY INVOLVED IN MISSION OPERATIONS AND MISSION ESSENTIAL GSE	X		X	
REPORT FAILURES FOR CHECKOUT EQUIPMENT AS INDICATED IN RELIABILITY PROGRAM PLAN	X		X	X
REPORT ALL SUSPECTED AND OBSERVED NONCONFORMANCES OF A FUNCTIONAL NATURE INCLUDING TRANSIENT CONDITIONS, HANDLING-INDUCED ANOMALIES AND OBSERVED UNEXPLAINABLE DEVIATIONS IN PERFORMANCE	X	X	X	
REPORT EACH FAILURE WITHIN TIME PERIODS STATED WITHIN CONTRACT	X	X	X	X
MAINTAIN A PROBLEM/FAILURE REPORTING SYSTEM FOR SOFTWARE DEFICIENCIES	1	2	3	4
REPORT PROBLEMS ASSOCIATED WITH TEST AND CHECKOUT PROCEDURES, TEST SPECIFICATIONS	X	X	X	
REPORT PROBLEMS IN OPERATING AND HANDLING INSTRUCTIONS	X	X	X	
REPORT PROBLEMS ASSOCIATED WITH COMPUTER PROGRAMS	X			
A REPORT PROBLEMS IN COMPUTER PROGRAMS ASSOCIATED WITH ON-BOARD MISSION EQUIPMENT	X	X		
B REPORT COMPUTER PROGRAM PROBLEMS OCCURRING DURING TEST, CHECKOUT AND LAUNCH OF MISSION HARDWARE	X	X	X	
C SOFTWARE PROBLEMS IN TEST, EXECUTION, AND POST-MISSION OPERATION	X	X		
THE SOFTWARE PROBLEM/FAILURE REPORTING SYSTEM SHALL BE COMPATIBLE WITH THE HARDWARE PROBLEM/FAILURE REPORTING SYSTEM	X	X	X	
REPORT DEFICIENCIES AND AMBIGUITIES WHICH ARE CONSIDERED POTENTIAL CONTRIBUTORS TO IMPROPER OPERATION OR FAILURE OF THE HARDWARE/MISSION	X	X	X	
SOFTWARE PROBLEM REPORTING SHALL BEGIN AT FIRST APPLICATION/SIGNOFF	X	X	X	
PROVIDE INVESTIGATION AND ENGINEERING ANALYSIS ON REPORTED PROBLEMS	1	2	3	4
PERFORM LABORATORY FAILURE ANALYSIS ON FAILURES FOR CRITICALITY I AND II AND CRITICALITY III BASED ON TREND ANALYSES	X	X	X	
CATEGORIZE FAILURES/PROBLEMS BY CRITICALITY	X	X	X	
DIFFERENTIATE BETWEEN FUNCTIONAL/NON-FUNCTIONAL NONCONFORMANCES	X	X	X	
RECURRENT NONCONFORMANCES WILL BE INVESTIGATED FOR INCLUSION IN PROBLEM REPORTING SYSTEM	X	X	X	



A NON-FUNCTIONAL NONCONFORMANCES	X
B FUNCTIONAL NONCONFORMANCES DURING IN-PROCESS TESTING, OR MATERIAL REVIEW BOARD ACTIONS	X X X
PROVIDE PROBLEM/FAILURE CLOSEOUT ACTIVITY	1 2 3 4
ACCOMPLISH AND DOCUMENT REMEDIAL AND PREVENTIVE ACTIONS	X X X
PROVIDE REVIEW OF PROBLEM CLOSURE TECHNICAL DECISIONS BY RELIABILITY AND BY HIGHER LEVELS OF TECHNICAL MANAGEMENT	X X X
PROVIDE FOR CLOSEOUT OF EACH REPORTED PROBLEM/FAILURE WITHIN TIME PERIODS DEFINED IN THE CONTRACT. CLOSEOUT REQUIRES THAT:	
A REMEDIAL ACTIONS HAVE BEEN ACCOMPLISHED	X X X
B NECESSARY PREVENTIVE DESIGN AND SOFTWARE CHANGES HAVE BEEN DEVICED AND ACCOMPLISHED	X X X X
C NECESSARY DESIGN CHANGES HAVE BEEN VERIFIED IN TEST	X
D CLOSEOUT HAS PROPER MANAGEMENT/RELIABILITY/QUALITY APPROVALS	X X X
E EFFECTIVITY OF PREVENTIVE ACTIONS HAS BEEN ESTABLISHED	X X X X
F THE PREVENTIVE ACTION HAS BEEN MADE IN EXISTING IDENTICAL ITEMS OF HARDWARE TO WHICH IT IS PERTINENT	X X X
1A306-2	
PROVIDE DOCUMENTATION FOR PROBLEM/FAILURE REPORTING/CORRECTION TASK	1 2 3 4
PROVIDE TIMELY DISEMINATION OF PROBLEM/FAILURE REPORTS WITHIN CONTRACTOR ORGANIZATION	X X X
DISSEMINATE SITE-GENERATED PROBLEM/FAILURE REPORTS WITHIN PLANT	X X
PROVIDE PROBLEM/FAILURE RESOLUTION STATUS TO APPROPRIATE FUNCTIONS	X X X
REQUIRE THAT SUBCONTRACTORS SUBMIT PROBLEM/FAILURE REPORT TO CONTRACTOR WITHIN THE PERIOD SPECIFIED IN THE CONTRACT	X X X
PROVIDE TIMELY DISTRIBUTION TO THE NASA OF PROBLEM/FAILURE REPORT AND ATTENDANT ANALYSIS REPORTS	X X X
REPORTING AND DATA PROCESSING ASPECTS OF CONTRACTORS SYSTEM SHALL BE COMPATIBLE WITH THE PROCURING NASA SYSTEM	X X X
THE RELIABILITY PROGRAM PLAN SHALL DESCRIBE THE FAILURE REPORTING SYSTEM INCLUDING REPORT FORMAT, NUMBERING SYSTEM, PROCEDURE, RESPONSIBILITIES BY CRITICALITY AND FUNCTIONAL CATEGORY	X X X X
THE COMPLEMENTARY INTERFACE IN RESPONSIBILITIES, PROCEDURES AND PRACTICES WITH THE QUALITY REPORTING EFFORT SHALL BE DISCUSSED IN THE RELIABILITY PROGRAM PLAN	X X X X
CUMULATIVE STATUS SUMMARIES COVERING EACH REPORTED PROBLEM SHALL BE SUBMITTED AS A PART OF THE PERIODIC RELIABILITY PROGRESS REPORTS	X
A FAILURE REPORT NUMBER AND SOURCE OF PROBLEM/FAILURE	X
B TEST AND SITE WHERE PROBLEM/FAILURE OCCURRED	X
C CRITICALITY CATEGORY	X
D PROBLEM/FAILURE DATE WITH PROJECTED CLOSEOUT	X
E IDENTIFICATION OF ITEM AFFECTED INCLUDING LOT NO, P/N, SERIAL	X
F IDENTIFICATION OF END ITEM, IF KNOWN	X
G BRIEF DESCRIPTION OF PROBLEM	X
H STATUS OF ANALYSIS AND CLOSEOUT ACTIVITY	X
I IDENTIFICATION OF FORMAL DOCUMENTATION CHANGES FOR CLOSEOUT	X
THE STATUS OF SIGNIFICANT OPEN FAILURES/PROBLEMS WILL BE DISCUSSED IN THE PERIODIC RELIABILITY MANAGEMENT MEETINGS	X X X



Task 8 - EEF Parts Program, and Materials Program

The required activities for the proper control of parts and materials used on the shuttle program shall be identified and controlled. Program requirements to be satisfied are listed in the matrix below:

Notes: A. Right Hand Columns designated as follows:

1. Baseline: NHB5300.4 1A
2. Air Vehicle Hardware Requirements
3. Mission Essential GSE
4. Non-Mission Essential GSE

1A307-1					
1A308-1					
IMPLEMENT PARTS FEE/MATERIALS PROGRAM	1	2	3	4	
PROGRAM CONSISTS OF SELECTION, STANDARDIZATION, SPECIFICATION, QUALIFICATION, APPLICATION, CORRECTIVE ACTION, HANDLING, ETC.	X	X	X		
USE NASA-PREFERRED PARTS IN NEW DESIGNS	X				
1A308-2					
MAINTAIN PARTS/MATERIALS ORGANIZATIONS	1	2	3	4	
USE QUALIFIED SPECIALISTS TO ADVISE DESIGN	X	X	X	X	
1A308-3					
PROVIDE PART SELECTION/SPECIFICATION CONTROLS	1	2	3	4	
MAINTAIN PARTS LISTS FOR THE NASA REVIEW	X	X	X	X	
NASA APPROVAL OF PARTS SELECTION REQUIRED	X				
CONTRACTOR RELIABILITY APPROVES SELECTION OF ALL EEF PARTS TO BE USED ON THE SHUTTLE			X	X	X
MAINTAIN STANDARD/PREFERRED PARTS LISTS FOR USE IN NEW DESIGNS	X	X	X		
1A308-4					
UTILIZE SPECIFICATION CONTROL FOR PARTS USED IN SHUTTLE HARDWARE	X	X	X	X	
SCREENING AND BURN-IN TEST REQUIRED	X	X	X		
PART FAILURE RATES SPECIFIED IN PROCUREMENT DOCUMENTS	X				
1A308-5					
ESTABLISH PART QUALIFICATION/CERTIFICATION TEST	1	2	3	4	
SELECT QUALIFIED PARTS WHERE POSSIBLE	X	X	X	X	
USE MIL-SPEC LEVEL PARTS QUALIFIED TO MIL-SPEC			X	X	
QUALIFY NEW PARTS FOR USE IN CRITICAL GSE			X		
QUALIFY ALL NEW PARTS FOR USE IN CRITICAL FUNCTIONS	X	X			
QUALIFY PARTS AND MATERIALS, AS REQUIRED	X	X	X		
REPORT QUALIFICATION STATUS OF PARTS/MATERIAL	X	X			
MAINTAIN A FILE OF PARTS/MATERIALS QUALIFICATION DATA	X	X			
1A308-6					
MAINTAIN A MATERIALS LIST PROJECT FOR SUBMITTAL TO THE NASA	X	X			
1A308-7					
CONDUCT PARTS/MATERIALS APPLICATION REVIEW	1	2	3	4	
REVIEW THE OPERATIONAL CHARACTERISTICS OF PARTS UNDER WORST-CASE ENVIRONMENTAL CONDITIONS TO ENSURE OPERABILITY	X	X			
1A308-8					
PARTS DATA SHALL BE MAINTAINED					
MAINTAIN AGE CONTROL AND TIME/CYCLE DATA FOR LIMITED-LIFE PARTS	X	X			



MAINTAIN RECORDED DATA FOR ACCEPTANCE AND SCREENING TEST ON PART	X
PROVIDE PARTS TRACEABILITY BACKWARD ONLY FOR SHUTTLE PARTS	X X
1A308-9	
MAINTAIN A FAILURE REPORTING/CORRECTIVE ACTION SYSTEM FOR PARTS	1 2 3 4
REPORT ALL POST-ACCEPTANCE TEST FAILURES	X
REPORT ALL PART FAILURES OCCURRING IN QUALIFICATION TESTS	X X X
REPORT PROBLEMS INSTEAD OF PIECE-PART FAILURES	X X X
CORRECTIVE ACTION REQUIRED ON PART FAILURES	X
CORRECTIVE ACTION REQUIRED ON PARTS USED IN CRITICAL FUNCTIONS	X X
AND NECESSARY FOR FUNCTION MAINTENANCE	1 2 3 4
MAINTAIN SUBCONTRACTOR PARTS CONTROLS	
PERFORM CORRECTIVE ACTION FOR PARTS CAUSING FAILURE IN HIGHER	
ASSEMBLY LEVEL	X
REQUIRE SUBCONTRACTORS TO SUBMIT A PARTS PROGRAM PLAN	X
SUBCONTRACTORS SHALL SUBMIT PARTS LISTS AND PART SPECIFICATIONS	X X
FAILURE REPORTING, CORRECTIVE ACTION, QUALIFICATION STATUS,	
APPLICATION REVIEWS SHALL BE REQUIRED FROM SUBCONTRACTOR PART	
PROGRAMS	X X
PROVIDE MATERIALS SPECIFICATION AND APPLICATION REVIEWS	1 2 3 4
ASSURE MATERIALS UTILIZED HAVE SPECIFICATIONS COMPATIBLE WITH	
RELIABILITY PROGRAM REQUIREMENTS	X X
INPUT DESIGN REVIEWS FROM RESULTS OF APPLICATION REVIEW	X X
ASSURE THAT A MATERIALS USAGE AND SUBSTITUTION LIST IS KEPT	X X X



## Task 9 - Testing

A planned program of testing and analysis shall be used to ensure the safe conclusion of defined program missions. Requirements are defined below:

Notes: A. Right Hand Columns Designated as follows:

1. Baseline: NHB5300.4 1A
2. Air Vehicle Hardware Requirements
3. Mission Essential GSE
4. Non-Mission Essential GSE

PROVIDE RELIABILITY EVALUATION PLAN	1	2	3	4
PROVIDE OUTLINE AND MILESTONES OF PROJECT TESTING PROGRAM	X			
PROVIDE SPECIFIC PLANS AND SCHEDULES FOR TESTING	X			
A IDENTIFY TESTS WHICH CONTRIBUTE TO THE ESTABLISHING/MEASURING AN/OR VERIFYING RELIABILITY	X			
B DESCRIBE ROLE OF TESTING IN RELIABILITY EVALUATION OF SYSTEM	X			
C IDENTIFY RELIABILITY-SIGNIFICANT TEST SEQUENCES	X			
D BY COMPONENT, SHOW HOW LIFE/OVERSTRESS TESTS ARE TO BE USED IN RELIABILITY EVALUATION.	X			
PROVIDE A TEST PROGRAM	1	2	3	4
THE CONTRACTORS TEST PROGRAM SHALL:				
A VERIFY CAPABILITY OF DESIGN	X			
B EVALUATE SUSCEPTABILITY TO FAILURE MODES UNDER USE CONDITIONS	X			
C IDENTIFY UNEXPECTED INTERACTIONS AMONG COMPONENTS	X			
D IDENTIFY FAILURE MODES REFLECTING WORKMANSHIP, MATERIALS, QC DEFICIENCIES	X			
E OBTAIN FAILURE RATES AND OTHER RELIABILITY DATA	X			
REVIEW/APPROVE DETAILED TEST PLANS/SET-UPS		X	X	
REVIEW ALL CERTIFICATION/QUALIFICATION TESTING TO EVALUATE FAILURE MODES OCCURRING DURING TEST FOR RELIABILITY IMPACT		X	X	
IDENTIFY HARDWARE DEFICIENCIES UNDER ENVIRONMENTAL/USE CONDITIONS		X	X	
PROVIDE VEHICLE CERTIFICATION	1	2	3	4
REVIEW/APPROVE LEVELS OF ASSEMBLY TO BE TESTED AND ENVIRONMENTS	X	X	X	
DEFINE CERTIFICATION REQUIREMENTS BASED ON CRITICALITY	X	X	X	
SUPPORT CERTIFICATION/QUALIFICATION BY PROVIDING PROGRAM GROUND RULES TO ENSURE RELIABILITY OBJECTIVES ARE MET.		X	X	
PREPARE AND MAINTAIN A CERTIFICATION STATUS LIST	X	X	X	
PREPARE TEST SPECIFICATIONS, PROCEDURES AND REPORTS	X			
PERFORM LIFE TESTING AND RELIABILITY DEMONSTRATION TEST	X			
PROVIDE RELIABILITY ASSESSMENTS FOR SYSTEM RELIABILITY	X			
INPUT RELIABILITY DATA TO READINESS REVIEWS	X	X	X	
REVIEW RELIABILITY EVALUATION EFFORT	X			



## RELIABILITY DICTIONARY

This dictionary contains descriptions of tasks that differ from or are not included in NHB5300.4 1A.

### TASK I

Past Technical Performance of each Potential Source of Supply - Utilize as a criterion of supplier selection the past reliability performance including failure and solution activities on similar technical endeavors.

Launch Site Reliability Plan Only - Limit off-site reliability plans to that dealing with the launch site due to the uniqueness of launch-associated problems. Other development activities are compatible with these normally within a reliability management plan.

Conduct Periodic (Quarterly) Contractor/NASA Program Management Reviews - The format of technical/status reviews on a periodic basis is the recommended approach to providing the essential element of reliability program management visibility in a timely manner. The scope of coverage includes:

- A. Status of task accomplishments/milestones.
- B. Recommended corrective actions for identified problem areas.
- C. Revisions in schedule.
- D. Identification of program actions/decisions affecting reliability with assessment of program impact.
- E. Advise of anticipated reliability program slippages.

Provide Formal Advice to the NASA Regarding any Incompatibility Between GFP and Shuttle System - The provision of the compatibility status of GFP and other program hardware is a reliability concern and all areas should be rigidly documented and reported to the NASA.

Provide a System for Assuring Integrity of Off-The-Shelf Hardware - To cope with those problems unique to the procurement of off-the-shelf designs and hardware, a system of defining discipline rigors and controls is a program requirement.



## TASK II DESIGN SPECIFICATION

Assure Definitions of Test Set-ups and Conditions -To preclude the variable of erroneous test set-up and performance and its potential impact on reliability program objectives, the review of the specified test activity has been defined as a reliability effort.

Assure Inspection Acceptance/Rejection Criteria are Defined -To minimize attendant reliability problems associated with nebulous acceptance/rejection requirements, reliability will assure design specifications properly address this parameter.

Ensure Use of Approved Materials and Parts - Provide a where-used review to assess the application of proper parts and materials.

Require Application of Approved Design, Process and Fabrication Practices - Assure by specification review that known and understood design and fabrication practices are employed.

## TASK III RELIABILITY EVALUATION

None

## TASK IV FAILURE MODE EFFECT ANALYSIS

Provide Estimated Time To Effect For All Identified Modes - This input shall reflect the elapsed time between mode of failure and its most severe consequence.

Perform FMEA At Level Indicated By Significance Of Function - Expenditure of technical effort and consequently, depth of FMEA detail, shall be determined by the significance of of hardware under review.

Create Logic Only as Required To Support Interpretation of FMEA - Logic Diagrams will not be generated as an end product but used as required to support numerical analysis in trades and for clarification of FMEA's.



#### TASK V MAINTAINABILITY/ELIMINATION OF HUMAN INDUCED FAILURES

Establish Anticipated Removal Rates Based On use/Test Data - Define anticipated removal rates for program equipment based on data from multiple sources and defined program use conditions.

Predict Removal Rates For That Hardware Having No Use History - Provide program guidance by predicting removal rates for new and state-of-art configurations which have no field data.

Support LRU Sizing and Replacement Studies - Provide removal rate estimates to support LRU sizing and planning studies.

Review Maintainability Controls and Documentation for Adequacy - Assure maintainability documentation/controls adequately define and control limited life and timecycle considerations.

#### TASK VI DESIGN REVIEW

Evaluate Designs at Part Level, Where Beneficial - Where complexity and use dictate additional review, reliability will initiate and sponsor effort.

Evaluate Changes in Process and Fabrication Procedures - Assure assessment of all proposed changes in design, fabrication/processing of critical hardware.

Assure Establishment of Margins of Safety and Proper Derating - Review designs to assure that program guidelines have been applied.

Assess Potential Development Problem Areas - Predict anticipated development problems based on similarity to existing hardware.

Review Adherence to Design Practices and Standards - Assure that design review identifies and is appropriately responsive to approved design practices and standards.

Review Adequacy of Specification and Control Documentation - Assure that design review identifies and is appropriately responsive to requirements of specification and other control documentation which impact reliability objectives.

Identify Potential Logistics/Sparing Problem Areas - Provide an assessment of unique sparing problems associated with design.

Evaluate Maintainability of Configuration Candidates - Review those maintainability elements associated with reliability - e.g., limited life, high failure expectancy hardware, etc.

Assure Selected Configurations Compatibility with Establish Reliability Requirements - Review proposed configuration to ensure compatibility and consistency with using end item reliability requirements.



Review Configuration Certification/Qualification Status - Assure the consideration of status of certification in the design solution selection process.

#### TASK VII

The Status of Significant Open Failures/Problems will be Discussed at the Periodic Reliability Management Meetings - Utilize the periodic management meetings to identify and establish a course of action for those failure/problems which the contractor has identified as potential program impacts.

#### TASK VIII EEE PARTS PROGRAM AND MATERIALS PROGRAM

Contractor Reliability Approves Selection of all EEE Parts to be Used on Shuttle - The contractor shall be held solely responsible for designs including parts and material selections and application.

Use Mil Spec Level Parts Qualified to Military Part Specifications - For selected Shuttle usage, parts with a Mil-spec qualification history are suggested.

Qualify all New Parts for Use in Critical Functions - Assure that all parts used in critical functions have a qualification/certification history compatible with intended use conditions.

Report Problems Instead of Piece-Part Failures - To minimize costs and attendant corrective action activities established by the Problem Reporting System, it is proposed that reporting of part failures be limited to those areas involving problems or significant failures such as qualification testing of parts.

Assure Material Utilized Have Specification Compatible with Reliability Program Requirements - Review material usage to ensure compatibility with program use, environmental and reliability imposed constraints.

#### TASK IX TESTING

Review/Approve Detailed Test Plans/Set-Ups - Review proposed testing activities to assure proper relieving of constraints.

Review all Certification/Qualification Testing to Evaluate Failures Modes During Test For Reliability Impact - Assess failure modes which occur during testing to identify potential operational deficiencies.

Identify Hardware Deficiencies Under Environmental/Use Conditions - Identify any operational characteristic or environmental sensitivities which may result in potential reliability problem areas.

Support Certification/Qualification by Providing Program Ground Rules to Ensure Reliability Objectives are Met - Provide those program ground rules which are necessary to impose proper rigor in certification cycle.

END OF DOCUMENT (ATS/360 41005010005:6)



QUALITY ASSURANCE  
PROGRAM REQUIREMENTS  
FOR  
SPACE SHUTTLE

PROGRAM MANAGEMENT PLAN

APPENDIX E

(ATS/360 41005010003:6)

SPACE DIVISION  
NORTH AMERICAN ROCKWELL



## QUALITY ASSURANCE

### APPENDIX E TO PROGRAM MANAGEMENT PLAN

NOTES: A. RIGHT HAND COLUMNS DESIGNATED AS FOLLOWS:

1. BASELINE: NHB5300.4 (1B)
2. AIR VEHICLE HARDWARE REQUIREMENTS
3. MISSION ESSENTIAL GSE
4. NON-MISSION ESSENTIAL GSE



## Q U A L I T Y   P R O G R A M

THE QUALITY ASSURANCE FUNCTION IS RESPONSIBLE FOR ESTABLISHING AND MAINTAINING AN EFFECTIVE AND ECONOMICAL SYSTEM WHICH ENSURES DELIVERY OF PRODUCTS OF ACCEPTABLE QUALITY. TO PROVIDE THIS ASSURANCE THE QUALITY ASSURANCE ORGANIZATION VERIFIES THAT ADEQUATE REQUIREMENTS ARE ESTABLISHED, PERFORMS INSPECTIONS, CONTROLS TESTS, PROVIDES MANAGEMENT SURVEILLANCE FOR THE QUALITY PROGRAM, AND OBTAINS CORRECTIVE ACTION AS NECESSARY.

1B200	QUALITY PROGRAM	1	2	3	4
	MAINTAIN AN EFFECTIVE AND TIMELY QUALITY PROGRAM	X	X	X	X
	THE PROGRAM SHALL:				
	RECOGNIZE THE QUALITY ASPECTS OF THE CONTRACT	X	X	X	X
	ENSURE QUALITY REQUIREMENTS SATISFIED THRU ALL PHASES	X	X	X	X
	ENSURE QUALITY ASPECTS INCLUDED IN ALL DESIGNS	X	X	X	X
	ENSURE QUALITY ASPECTS CONTINUOUSLY MAINTAINED	X	X	X	X
	PROVIDE FOR DETECTION OF DEFICIENCIES	X	X	X	X
	PROVIDE REMEDIAL AND PREVENTIVE ACTION	X	X	X	X
1B2011	ORGANIZATION	1	2	3	4
	ASSIGNMENTS SHALL BE MADE TO IMPLEMENT EACH ELEMENT	X	X	X	X
	PERSONNEL SHALL ASSESS PROBLEMS AND EFFECT SOLUTIONS	X	X	X	X
	EFFECTIVENESS SHALL BE MAINTAINED DURING ALL PHASES	X	X	X	X
	ONE INDIVIDUAL SHALL BE RESPONSIBLE FOR THE PROGRAM	X	X	X	X
	HE SHALL HAVE DIRECT ACCESS TO HIGHER MANAGEMENT	X	X	X	X
	HE SHALL REPORT STATUS REGULARLY TO HIGHER MANAGEMENT	X	X	X	X
1B2012	QUALITY ELEMENTS	1	2	3	4
	QUALITY ORGANIZATION SHALL RETAIN THESE ELEMENTS:				
	ESTABLISH QUALITY POLICY AND DOCUMENT RESPONSIBILITY	X	X	X	
	ENSURE QA PROVISIONS AS MEMBER OF DESIGN CHANGE BOARD	X	X		
	ESTABLISH QUALITY LEVELS AND REQUIREMENTS	X	X		
	PREPARE INSPECTION PLANS AND CRITERIA	X	X		
	ASSURE QA ADEQUACY OF PROCESS SPECS, PROC DOCS ETC	X	X		
	PERFORM QUALITY AUDITS ( INTERNAL & EXTERNAL)	X	X	X	
	PARTICIPATE IN DISPOSITION OF NONCONFORMANCES	X	X	X	
	CLASSIFY PRODUCT PROPERTIES AS APPLICABLE	X	X		
	PERFORM INSPECTIONS & WITNESS TESTS	X	X	X	
	ASSIST TRAINING IN QA METHODS	X	X	X	
	ENFORCE REMEDIAL AND PREVENTATIVE ACTION PROCEDURES	X	X		
	ASSURE QUALIFIED EMPLOYEES PERFORM ALL OPERATIONS	X	X		
	ENFORCE MATERIALS AND EQUIPMENT REQUIREMENTS	X	X		
	ENFORCE NONMETALLIC MATERIAL REQUIREMENTS	X			
	MAINTAIN QUALITY TREND DATA	X	X		
	ENFORCE CLEANLINESS REQUIREMENTS	X	X		
	ACCEPT/REJECT PRODUCT	X	X	X	
	WITNESS QUALIFICATION & ACCEPTANCE TESTS	X	X	X	
	ASSURE GFE CONTROL	X	X	X	
	ASSURE ADEQUATE QUALITY REQUIREMENTS IN PROCUREMENTS	X	X		
	MANAGE SUPPLIER/SUBCONTRACTOR QUALITY ACTIVITIES	X	X		



	ASSURE QUALITY CONTROL OF PACKAGING AND HANDLING	X	X	X
	PARTICIPATE IN PROGRAM REVIEWS RE PRODUCT QUALITY	X	X	
	MONITOR CONTROL OF LIMITED LIFE ITEMS	X	X	
	MAINTAIN SUPPORT OF TURNAROUND & MAINTENANCE TASKS	X	X	
1B2021	TRAINING	1	2	3 4
	THE CONTRACTOR SHALL HAVE TRAINED AND COMPETENT PERSONNEL	X	X	X
	TRAINING SHALL BE DEVELOPED TO SATISFY QUALITY REQMTS	X	X	X
	SUPERVISORS SHALL HAVE KNOWLEDGE OF SKILLS & PROCESSES		X	X
	PROVIDE A LIST OF PROCESSES REQUIRING TRAINING TO NASA		X	X
	TRAINING & QUALIFICATION PLANS SHALL BE PREPARED		X	X
	TRAINING ACTIVITIES SHALL BE DOCUMENTED AND PROVIDE FOR:			
	EXCELLENCE OF WORKMANSHIP & PERSONNEL SKILLS	X	X	X
	CAPEFUL AND SAFE OPERATIONS	X	X	X
	MAINTENANCE & IMPROVEMENT OF ARTICLE & MATERIAL QUALITY	X	X	X
1B2022	CERTIFICATION OF PERSONNEL	1	2	3 4
	DEFINE PROCESSES & OPNS REQUIRING CERTIFIED PERSONNEL	X	X	X X
	CERTIFICATIONS MAY BE REVIEWED BY THE NASA	X	X	X X
	CERTIFICATION SHALL BE BASED ON TRAINING & TESTING	X	X	X X
	PERSONNEL SHALL BE GIVEN EVIDENCE OF CERTIFICATION	X	X	X X
1B2023	RECERTIFICATION OF PERSONNEL	1	2	3 4
	RECERTIFICATION OF PERSONNEL SHALL BE REQUIRED WHEN:			
	UNSATISFACTORY QUALITY OF ARTICLES/MATERIALS OBSERVED	X		
	PROFICIENCY REQUIREMENTS ARE NOT MET		X	X
	NEW TECHNIQUES OR HARDWARE REQUIRE NEW SKILLS	X	X	X
	WORK PERIOD IS INTERRUPTED	X	X	X
	RECERTIFICATION REQUIRES RETESTING	X	X	X
	RECERTIFICATION BASED ON CONTINUOUS DEMONSTRATED PERF.		X	X
1B2024	RECORDS	1	2	3 4
	RECORDS SHALL BE MAINTAINED FOR:			
	TRAINING, TESTING AND CERTIFICATION STATUS OF PERSONNEL		X	X
	TRAINING & TESTING STATUS OF PERSONNEL		X	X
	PROCESSES REQUIRING TRAINING		X	X
1B203	QUALITY INFORMATION	1	2	3 4
	PROCESSING OF QUALITY INFORMATION SHALL BE PROVIDED	X	X	X
	QUALITY INFORMATION SHALL BE SENT TO ALL CONCERNED AREAS	X	X	X
	PREPARE TIME-PHASED LISTING OF PLANNED & EXPENDED MANHOURS		X	X
	MAINTAIN & USE QUALITY CCST DATA AS A MGT. ELEMENT		X	X
1B204	QUALITY STATUS REPORTING	1	2	3 4
	REPORT SHALL BE PRESENTED QUARTERLY PER DRD		X	X
	REPORT CONTENTS AS FOLLOWS:			
	PROBLEMS-MANAGEMENT & HARDWARE	X	X	X
	PERTINENT DATA-TRENDS		X	X
	SCOPE-IN-HOUSE AND SUBCONTRACTOR CPIT 1		X	X
	CHANGES IN QA BUSINESS SYSTEMS		X	X X
	REPORTS SHALL BE SUPPORTED BY MEETINGS		X	X



1B2051	QUALITY PROGRAM AUDITS	1	2	3	4
	AUDITS SHALL BE CONDUCTED OF QUALITY OPERATIONS	X	X	X	
	AUDITS SHALL BE PERFORMED BY AN INDEPENDENT GROUP	X	X	X	
	EACH AUDIT SHALL INCLUDE:				
	EXAMINATION OF ALL OPERATIONS	X	X	X	
	EXAMINATION OF ALL DOCUMENTATION	X			
	EVALUATION OF ACTUAL OPERATIONS	X			
	COMPARISON WITH ESTABLISHED REQUIREMENTS	X			
	RECOMMENDATIONS FOR REMEDIAL & PREVENTIVE ACTIONS	X	X	X	
	FOLLOW UP TO ASSESS RESULTS OF RECOMMENDATIONS	X	X	X	
	AUDITS SHALL INCLUDE EXAMINATION OF PRODUCT	X	X	X	
	AUDITS SHALL BE LIMITED TO PRODUCT AND RELATED DOCUMENTS	X	X		
	THE AUDIT PROGRAM WILL BE PRODUCT ORIENTED AND				
	CORRELATED TO THE DOCUMENTATION AND SYSTEMS WHICH				
	SUBSTANTIATE AND DEFINE THE FABRICATION, ASSEMBLY				
	AND TEST OPERATIONS.				
	REMEDIAL & PREVENTIVE ACTION MAY INCLUDE SYSTEMS		X	X	
1B2052	UNSCHEDULED AUDITS	1	2	3	4
	RANDOM UNSCHEDULED AUDITS SHALL BE PERFORMED	X	X	X	
1B2053	AUDIT REPORTS	1	2	3	4
	RESULTS OF AUDITS SHALL BE REPORTED TO HIGHER MGMT	X	X	X	
	MANAGEMENT SHALL ENSURE CORRECTION OF DEFECIENCES	X	X	X	
1B2061	QUALITY PROGRAM PLAN	1	2	3	4
	A QPP SHALL BE PREPARED , MAINTAINED AND IMPLEMENTED	X			
	THE PLAN SHALL DESCRIBE HOW QUALITY REQMTS ARE ASSURED	X	X	X	
	THE PLAN SHALL BE SUBMITTED AS REQUIRED BY DRD		X	X	
	THE PLAN SHALL PEADILY IDENTIFY EACH REQUIREMENT	X	X	X	
	THE PLAN SHALL BE UPDATED PERIODICALLY	X			
1B2062	QUALITY PROGRAM PLAN CONTENTS	1	2	3	4
	THE QUALITY PROGRAM PLAN SHALL INCLUDE:				
	A DESCRIPTION OF EACH IMPLEMENTING ORGANIZATION ELEMENT	X	X	X	X
	STATEMENTS OF DUTIES, FUNCTIONS AND RESPONSIBILITIES	X	X	X	X
	RELATIONSHIP OF EACH ELEMENT PERFORMING QUALITY TASKS	X	X	X	X
	DESCRIPTION OF EXECUTION & MANAGEMENT OF EACH TASK	X	X	X	X
	ORGANIZATION AND METHCDS FOR ACCOMPLISHMENT	X	X	X	X
	REFERENCE TO APPLICABLE POLICIES AND PROCEDURES	X	X	X	X
	LIST OF DOCUMENTS & OPERATIONS REQUIRING CHANGE	X	X	X	X
	A PLAN FOR IMPLEMENTING PROPOSED CHANGES	X	X	X	X
	MFG & TEST FLOW CHARTS	X	X	X	X
	COPIES OF REFERENCED POLICIES & PROCEDURES PROVIDED PER DRD	X	X	X	X
1B2063	SITE PLANS	1	2	3	4
	PLANS SHALL BE PREPARED FOR EACH SITE	X			



## DESIGN AND DEVELOPMENT CONTROLS

THE DESIGN AND DEVELOPMENT CONTROL SECTION OF THE QUALITY PROGRAM PLAN WILL DEFINE CONTROLS, REQUIREMENTS, AND VERIFICATIONS USED TO ENSURE PROPER INCORPORATION OF ENGINEERING AND QUALITY REQUIREMENTS INTO THE SPACE SHUTTLE PROGRAM. ADDITIONAL DEFINITION HAS BEEN MADE IN THE AREAS OF USE OF PRODUCT PROPERTIES PROGRAM, PRODUCT CONFIGURATION AUDIT INSPECTION, INTERNAL & PROGRAM MILESTONE DESIGN REVIEWS, AND PROGRAM ACCEPTANCE REVIEWS.

1B3001	TECHNICAL DOCUMENTATION	1	2	3	4
	ESTABLISH AND IMPLEMENT DESIGN CONTROL REQUIREMENTS	X			
	ENSURE COMPLIANCE WITH DESIGN CONTROL REQUIREMENTS	X	X	X	X
	ESTABLISH AND ENSURE COMPLIANCE TO QUALITY CRITERIA	X	X	X	X
	DEVELOP TECHNICAL DOCUMENTS INCORPORATING:				
	CHARACTERISTICS AND DESIGN CRITERIA	X			
	CHARACTERISTIC TOLERANCES	X			
	IDENTIFICATION	X			
	QUALITY CRITERIA	X	X	X	X
	REVIEW TECH DOCUMENTS FOR ALL WORK PHASES INCLUDING:				
	PROCUREMENT	X	X	X	
	FABRICATION AND ASSEMBLY	X	X	X	
	INSPECTION AND TEST OPERATIONS	X	X	X	
	TECHNICAL DOCUMENTS SHALL INCLUDE:				
	SPECIFICATIONS	X			
	PROCEDURES	X			
	DRAWINGS	X			
	FABRICATION AND PLANNING DOCUMENTS	X			
	PROCESS SHEETS	X			
	QUALITY SHALL REVIEW ALL QUALITY RELATED DOCUMENTS	X	X	X	X
	QUALITY REVIEWS SHALL SUPPORT:				
	INTERNAL REVIEWS		X	X	
	PROGRAM MILESTONE REVIEWS		X	X	
	DEVELOP A PRODUCT PROPERTIES CATEGORIZATION SYSTEM		X		
	A PROGRAM SHALL BE DEVELOPED CATEGORIZING				
	CHARACTERISTICS WHICH REQUIRE MORE DEFINITIVE				
	CONTROL THAN CHARACTERISTICS OF LESS SIGNIFICANCE.				
	CRITERIA FOR IDENTIFYING AND DOCUMENTING SUCH				
	CHARACTERISTICS SHALL BE ESTABLISHED.				
	IDENTIFY PRODUCT PROPERTIES BY CRITICALITY		X		
	PRODUCT PROPERTIES SYSTEM SHALL BE USED FOR:				
	DEVELOPING QUALITY INSPECTION AND TEST PLANNING		X		
	DEVELOPING MANDATORY INSPECTION POINTS		X		
	DEVELOPING WORKMANSHIP AND QUALITY STANDARDS		X		
	DEVELOPING INSPECTION PROCEDURES		X		
	DEVELOPING QUALITY CRITERIA		X		
1B3002	DOCUMENT REVIEW	1	2	3	4
	CONDUCT QUALITY REVIEW OF TECHNICAL DOCUMENTS	X	X	X	
	QUALITY REVIEW SHALL BE TIMELY AND SHALL INCLUDE:				
	REVIEW OF DOCUMENT CHANGES	X	X	X	



	MAINTENANCE OF RECCRDS OF REVIEWS	X	X	X
	REPORTING DOCUMENT DEFICIENCIES	X	X	X
	ASSURING DOCUMENT CORRECTION PRIOR TO RELEASE	X	X	X
	PROVIDE QUALITY INFORMATION FROM REVIEWS FOR USE IN:			
	PROCUREMENT PLANNING	X	X	X
	FABRICATION PLANNING	X	X	X
	INSPECTION AND TEST PLANNING	X	X	X
1B301	QUALITY SUPPORT TO DESIGN REVIEWS AND PMR'S	1	2	3 4
	QUALITY ASSURANCE SHALL PARTICIPATE IN DESIGN REVIEWS	X	X	X
	QUALITY DESIGN REVIEW SHALL ENSURE:			
	PRODUCIBILITY OF DESIGN	X	X	X
	INSPECTABILITY OF DESIGN	X	X	X
	REPEATABILITY OF DESIGN	X	X	X
	DESIGN OBTAINS RELATED QUALITY CONSIDERATIONS	X	X	X
	TRACEABILITY REQUIREMENTS		X	X
	INSPECTION AND TEST CRITERIA		X	X
	CONFORMANCE AND/OR TOLERANCE LIMITS		X	X
	CONTAMINATION CONTROLS		X	X
	LIMITED LIFE PROVISIONS		X	X
	INTEGRATE QA CONSIDERATIONS INTO DESIGN REVIEWS		X	X
1B3012	PROGRAM MILESTONE DESIGN REVIEW (PRR, PDR, CDR)	1	2	3 4
	QUALITY ASSURANCE REVIEW SHALL ENSURE:			
	REPEATABILITY AND INSPECTABILITY OF DESIGN		X	X
	STATE-OF-THE-ART INSPECTION CAPABILITIES		X	X
	CONFORMANCE CRITERIA ESTABLISHED		X	X
	INTERFACE QUALITY CONTROLS AND DOCUMENTS		X	X
	PROCESS SPECS AND QUALITY CONTROLS DEFINED		X	X
	TEST SPEC AND TEST REQUIREMENTS ADEQUACY		X	X
1B3013	PRODUCT CONFIGURATION AUDIT INSPECTION	1	2	3 4
	PRODUCT CONFIGURATION AUDIT INSPECTION SHALL INCLUDE:			
	TEST RESULTS AND ANOMALIES AND ACTION TAKEN		X	X
	FAILURE SUMMARY AND CORRECTIVE ACTION		X	X
	OPEN ITEM STATUS		X	X
	QUAL TEST UNIT VS END-ITEM CONFIG COMPARISON		X	X
	QUAL AND ACCEPTANCE TEST PERFORMANCE VERIF		X	X
	QUALITY RELATED FAILURE/CORRECT ACTION SUMMARY		X	X
	VERIF OF CONFORMANCE TO QUALITY PROGRAM REQMTS		X	X
1B3014	PROGRAM ACCEPTANCE REVIEWS	1	2	3 4
	QUALITY SUPPORT OF PROG ACCEPT REVIEWS SHALL ENSURE:			
	ACCEPTANCE DATA PACKAGE REQMTS ARE ESTABLISHED		X	X
	REVIEW OF HARDWARE CONFIGURATION STATUS		X	X
	IDENTIFY AND STATUS OF WAIVERS AND DEVIATIONS		X	X
	CRITICAL LIFE COMPONENT STATUS		X	X
	IDENTIF OF SHORTAGES AND OPEN WORK ITEMS		X	X
	EVALUATION/VALIDATION OF FINAL TEST RESULTS		X	X
	DEVELOPMENT OF FORM DD250		X	X



VERIFICATION OF CONFORMANCE TO SHIPPING REQMTS	X	X		
SUPPORT MANUALS/DOCUMENTS ARE WITH END-ITEMS	X	X		
1B302 CHANGE CONTROL	1	2	3	4
MAINTAIN A CHANGE CONTROL SYSTEM TO:				
DISTRIBUTE APPROVED DOCUMENTS	X			
REMOVE OBSOLETE DOCUMENTS	X			
INITIATE CHANGE REQUESTS	X			
MAINTAIN AN INTERFACE CONTROL SYSTEM	X			
INTEGRATE THIS SYSTEM WITH OTHER DOC CONTROL SYSTEMS	X			
QA PARTICIPATE AS MEMBER OF CCB		X	X	X
QUAL ASSUR ESTABLISH A DCC CONTROL SYSTEM TO:				
DISTRIBUTE QUAL GENERATED DOCUMENTS		X	X	
REMOVE OBSOLETE QUAL DOCUMENTS		X	X	
QUAL ASSUR REVIEW ALL ENGINEERING CHANGES		X	X	X
SPECIFY EFFECTIVITY POINT OF CHANGES ON DOCUMENTS	X			
ASSURE CHANGES ARE ACCOMPLISHED AND MARKED ON PARTS	X			
VERIFY ASSOCIATED DOCUMENTS ARE REVISED	X			
PROVIDE FOR INSPECTION/TEST OF CHANGED PARTS	X			
QUALITY ASSURANCE SHALL VERIFY:				
EFFECTIVITY POINTS ARE IDENTIFIED		X	X	X
CHANGES TO PARTS ARE ACCOMPLISHED		X	X	X
CHANGED PARTS ARE MARKED		X	X	X
ASSOCIATED DOCUMENTS ARE REVISED		X	X	X
PROVISIONS ARE INCLUDED FOR INSPECTION & TEST		X	X	X



## IDENTIFICATION AND DATA RETRIEVAL

THE IDENTIFICATION AND DATA RETRIEVAL SECTION OF THE QUALITY PROGRAM PLAN WILL DEFINE CONTROLS AND METHODS USED FOR HARDWARE AND DATA IDENTIFICATION THROUGHOUT ALL LEVELS OF PROCUREMENT, FABRICATION AND TEST. THE IDENTIFICATION SYSTEM WILL BE MAINTAINED IN CONJUNCTION WITH OTHER CONTRACTOR SYSTEMS TO ASSURE COMPATIBILITY AND COMMON USE OF IDENTIFICATION NUMBERS AND PROCEDURES.

1B400	IDENTIFICATION AND DATA RETRIEVAL	1 2 3 4
	MAINTAIN AN IDENTIFICATION & DATA RETRIEVAL SYSTEM TO:	
	PROVIDE ID TO WHICH OPERATING RECORDS ARE RELATED	X
	PROVIDE MEANS FOR LOCATING ARTICLES/MATERIALS	X
	THE QA ORGANIZATION SHALL ASSURE THAT THE SYSTEM:	
	IS IN ACCORDANCE WITH DATA MGMT REQUIREMENTS	X X X
	IDENTIFIES ARTICLES AND MATERIALS	X X X
	IDENTIFIES RECORDS TO HARDWARE PROCESSES	X X X
	LOCATES ARTICLES AND MATERIALS	X X X
1B401	IDENTIFICATION METHODS	
	IDENTIFY EACH ARTICLE AS REQUIRED BY SPEC	X
	THE QA ORGANIZATION SHALL ASSURE THE FOLLOWING:	
	IDENTIFICATION OF ARTICLE BY NO AND LOCATION	X X X
	IDENTIFICATION BY DATE OF AGE SENSITIVE ITEMS	X X X
	IDENTIFICATION OF GROUPS BY LOT NUMBERS	X X X
	UNIQUE ITEMS IDENTIFIED BY SERIAL NUMBERS	X X X
	NASA APPROVAL OF OTHER IDENTIFICATION	X X X
1B402	DOCUMENTATION	
	SPECIFY IDENTIFICATION METHOD & LOCATION ON DRAWING/SPEC	X
	ASSURE IDENTIFICATION METHOD & LOCATION ON DRAWING/SPEC	X X X
1B403	IDENTIFICATION CONTROL	1 2 3 4
	THE QA ORGANIZATION SHALL ASSURE THE FOLLOWING:	
	NUMBERS ARE ASSIGNED IN A CONSECUTIVE MANNER	X X X X
	RECORDS SHALL INDICATE PART NUMBERS AND IDENTIFICATION	X X X X
	PROVIDE CAPABILITY OF TRACING BACKWARD TO MATERIAL	X X X
	PROVIDE CAPABILITY OF TRACING FORWARD TO LIKE ARTICLES	X X X
	NUMBERS ARE NOT REUSED	X X X X
	ARTICLES IDENTIFIED 'NOT FOR FLIGHT USE' AS APPLICABLE	X
1B404	IDENTIFICATION LIST	1 2 3 4
	THE CONTRACTOR SHALL ESTABLISH & MAINTAIN AN IDENT LIST	X
	THE QA ORGANIZATION SHALL ASSURE THE FOLLOWING:	
	AN IDENT LIST FOR CONTRACTOR & SUPPLIER ARTICLES	X X X X
	PART NO, TYPE OR INDIVIDUAL IDENTIFICATION	X X X X
1B405	RETRIEVAL OF RECORDS	1 2 3 4
	ASSURE RELATION OF RECORDS FROM PROCUREMENT THRU TEST TO:	
	ARTICLES & MATERIALS SPECIFIED IN IDENTIFICATION LIST	X X
	ENSURE LOCATION & RETRIEVAL OF ARTICLES OR MATERIALS	X X



## PROCUREMENT CONTROLS

THE PROCUREMENT CONTROL SECTION OF THE QUALITY PROGRAM PLAN WILL DEFINE CONTROLS USED IN SELECTION OF SUPPLIERS AND METHODS USED TO ENSURE SUPPLIER COMPLIANCE WITH TECHNICAL AND PURCHASE DOCUMENT REQUIREMENTS.

1B500	GENERAL	1	2	3	4
	THE CONTRACTOR SHALL INSURE ADEQUACY OF:				
	PURCHASED PARTS, MATERIALS AND SERVICES	X			
	THE QUALITY ASSURANCE ORGANIZATION SHALL:				
	PARTICIPATE IN SELECTION OF SOURCES		X	X	
	REVIEW AND APPROVE APPROPRIATE PURCHASE ORDERS		X	X	
	PROVIDE TECHNICAL ASSISTANCE/TRAINING TO SUPPLIERS		X	X	
	REVIEW AND APPROVE SUPPLIER QA SYSTEMS		X	X	
	PROVIDE RESIDENT/ITINERANT REPS		X	X	
	MONITOR SUBCONTRACTOR QUALITY PERFORMANCE		X	X	
	AUDIT SUPPLIER QUALITY PERFORMANCE		X	X	
	EVALUATE SUBCONTRACTOR/SUPPLIER RESPONSES TO RFP		X	X	
1B501	SELECTION OF PROCUREMENT SOURCES	1	2	3	4
	QUALITY ASSURANCE BASIS FOR SELECTION SHALL INCLUDE:				
	REVIEW OF QUALITY HISTORY		X	X	X
	PRE AWARD SURVEYS		X	X	X
	ESTABLISH INSP REQMTS FOR ITEMS NOT UNDER NASA CONTRACT	X			X
	ESTABLISH SELF VERIF. PROGRAM FOR SELECTED SUPPLIERS		X	X	X
	SELECTED SUPPLIERS WILL BE AUTHORIZED TO DETERMINE				
	PRODUCT ACCEPTABILITY THROUGH DESIGNATED SUPPLIER				
	QA REPRESENTATIVES HAVING CONTRACTOR APPROVAL.				
1B502	PROCUREMENT DOCUMENTS	1	2	3	4
	REVIEW PRIOR TO RELEASE TO ASSURE:				
	PLACEMENT WITH APPROVED SOURCES		X	X	X
	ADEQUACY OF QUALITY REQUIREMENTS		X	X	X
	FOLLOWING QA REQMTS APPLY AS APPLICABLE:				
	CHANGE APPROVAL		X	X	X
	RAW MATERIAL TEST RESULTS		X	X	X
	AGE/LIMITED LIFE CONTROLS		X	X	X
	MATERIAL PRESERVATION AND PACKAGING		X	X	X
	IDENTIFICATION		X	X	X
	DATA RETRIEVAL REQUIREMENTS		X	X	X
	INSPECTION AND TEST REQUIREMENTS		X	X	X
	NONCONFORMING ARTICLE CONTROL		X	X	X
	CONTRACTOR QA COVERAGE		X	X	X
	GOVERNMENT SOURCE INSPECTION		X	X	X
	EQUIPMENT RECORDS:				
	DATA PACKAGE			X	X
	PRESSURE VESSEL HISTORY			X	X
	SUPPLIER LISTING OF CRITICAL PROCESSES			X	X
1B503	CONTRACTOR QA PERSONNEL AT SOURCE	1	2	3	4



	SOURCE ASSIGNMENTS OPTIONAL EXCEPT WHEN:	
	REQUIRED BY PROCESS/END ITEM CONTROL	X X X
	VERIFICATION TESTS ARE DESTRUCTIVE	X X X
	ENVIRONMENT/TEST EQUIPMENT CANNOT BE DUPLICATED	X X X
	PERFORMANCE NOT SATISFACTORY	X X X
	QUALITY HISTORY INDICATES NEED	X X X
	QUAL TEST TO BE PERFORMED BY SUPPLIER	X X X
	HARDWARE IS TO BE SHIPPED DIRECT TO USING SITE	X X X
	CRIT I ITEMS TESTED BY SUPPLIER	X X
	SOURCE PERSONNEL DUTIES TO BE DOCUMENTED	X X X
1B504	GOVERNMENT SOURCE INSPECTION	1 2 3 4
	DETERMINATION MADE BY NASA	X X X X
	NOT IN LIEU OF CONTRACTOR INSPECTION	X X X
	POLICY TO BE DEVELOPED	X X X
1B505	RECEIVING INSPECTION SYSTEM	1 2 3 4
	VERIFY INDICATION OF INSPECTION ACCEPTANCE	X X X X
	IDENTIFY ARTICLES AS TO INSPECTION STATUS	X X X X
	VERIFY CHARACTERISTICS NOT SOURCE INSPECTED	X X X
	PERIODIC DISASSEMBLY	X
	VERIFY DATA	X X X X
	PROVIDE ADEQUATE EQUIPMENT AND INSTRUCTIONS	X X X
	PROVIDE AGE CONTROL/LIMITED LIFE CONTROLS	X X X
	VERIFY CHEMICAL/PHYSICAL TESTING	X X X X
	PRECLUDE QUALITY DEGRADATION DURING STORAGE	X X X X
	ASSURE CONTROL & PACKAGING ADEQUACY	X X X X
	RECORD INSPECTION STATUS	X X X X
1B506	RECEIVING INSPECTION RECORDS	1 2 3 4
	MAINTAIN RECEIVING INSP./TEST RECORDS TO INCLUDE:	
	DATE OF RECEIPT	X X X X
	EXTENT OF INSPECTION/TEST	X X X X
	INSPECTION/TEST RESULTS	X X X X
	TYPE OF DATA RECEIVED	X X X X
	DISPOSITION OF RECEIVALS	X X X X
	TEST PROCEDURES USED	X X X X
1B507	SUPPLIER RATING SYSTEM	1 2 3 4
	RECORD SOURCE/RECEIVING INSP. & TEST RESULTS	X X X X
	MAINTAIN A SUPPLIER RATING SYSTEM	X X X
	UTILIZE RATING SYSTEM TO AID IN SOURCE SELECTION	X X X X
	DEVELOP QUALITATIVE/QUANTITATIVE DATA	X X X X
1B508	POST AWARD SURVEY OF SUPPLIER OPERATIONS	1 2 3 4
	SCHEDULE AND CONDUCT POST AWARD SURVEYS	X
	SCHEDULE AND CONDUCT PRODUCT ORIENTED AUDITS	X X
	PRODUCT ORIENTED AUDITS SHALL BE CONDUCTED AS	
	OPPOSED TO SURVEYS, BUT SHALL INCLUDE DOCUMENTATION	
	AND SYSTEM EVALUATION AS DIRECTLY RELATED TO THE	
	PRODUCT.	



	CONDUCT DISASSEMBLY AUDITS AT SOURCE				X	X
	CONDUCT PROCESS AUDITS AT SOURCE				X	X
	AUDIT SCHEDULES BASED ON:					
	CRITICALITY OF ITEM				X	X X
	KNOWN PROBLEMS				X	X X
	QUALITY HISTORY				X	X X
	SUPPLIER CAPABILITY				X	X X
	REMAINING PERIOD OF PERFORMANCE				X	X X
	DOCUMENT AUDIT RESULTS				X	X X
	OBTAIN CORRECTIVE ACTION				X	X X
1B509	COORDINATION OF INSPECTION/TEST				1	2 3 4
	ASSURE COMPATIBILITY				X	X X X
	DETERMINE NEED OF TRAINING				X	X X
1B510	NONCONFORMANCE INFORMATION FEEDBACK				1	2 3 4
	PROVIDE FEEDBACK TO SUPPLIER				X	X X
	ASSURE EFFECTIVE REMEDIAL & PREVENTIVE ACTION				X	X X
	PROVIDE STATUS TO FIELD REPRESENTATIVES					X X
	COORDINATE WITH GSI REPS					X X
1B511	COORDINATION OF MEASURING/TEST EQUIPMENT				1	2 3 4
	CORRELATE INSPECTION/TEST PROCEDURES WITH SUPPLIER				X	X
	A PROGRAM SHALL BE IMPLEMENTED TO PROVIDE ASSURANCE					
	THAT CONTRACTOR/SUPPLIER TEST EQUIPMENT & PROCEDURES					
	ARE COMPATIBLE WITH RESPECT TO DETERMINING PRODUCT					
	ACCEPTABILITY.					
	CORRELATE TYPE OF TEST EQUIPMENT				X	X
	VERIFY USE OF SPECIFIED EQUIPMENT				X	X
	ASSURE ADEQUACY OF CALIBRATION/CERTIFICATION PROCEDURES				X	X



## F A B R I C A T I O N   C O N T R O L S

THE FABRICATION CONTROL SECTION OF THE QUALITY PROGRAM PLAN WILL DEFINE CONTROLS AND VERIFICATIONS USED TO ENSURE PROPER INCORPORATION OF ENGINEERING AND QUALITY REQUIREMENTS INTO THE SPACE SHUTTLE PROGRAM. ADDED DETAIL HAS BEEN PROVIDED IN THE AREAS OF NDE AND CONTROL OF TEMPORARY INSTALLATIONS.

1B600	FABRICATION CONTROLS	A	1	2	3	4
	FABRICATION DOCUMENTS SHALL INCLUDE OR REFERENCE:					
	IDENTIFICATION OF THE ARTICLE					X
	TOOLING AND EQUIPMENT TO BE USED					X
	CHARACTERISTICS AND TOLERANCES					X
	PROCESS CONTROLS					X
	SPECIAL PROCESSING CONDITIONS					X
	WORKMANSHIP STANDARDS					X
	ASSURE THAT FABRICATION DOCS INCLUDE OR REFERENCE:					
	IDENTIFICATION OF THE ARTICLE					X X X
	TOOLING AND EQUIPMENT TO BE USED					X X X
	CHARACTERISTICS AND TOLERANCES					X X X
	PROCESS CONTROLS					X X X
	SPECIAL PROCESSING CONDITIONS					X X X
	WORKMANSHIP STANDARDS					X X
	CLEANLINESS LEVELS					X X
	INSPECTION & TEST OPERATIONS TO BE PERFORMED					X X
	REQMTS FOR SPECIAL HANDLING & PROTECTIVE DEVICES					X X
1B601	ARTICLE AND MATERIAL CONTROLS		1	2	3	4
	VERIFY ONLY CONFORMING MATERIAL OR ARTICLE RELEASED					X X X X
	MAINTAIN RECORDS ON AGE OR USE SENSITIVE ITEMS					X X X X
	VERIFY ADHERANCE TO ENVIRONMENTAL CONSTRAINTS					X X X
	VERIFY ADHERANCE TO CONTAMINATION CONTROLS					X X X
1B602	CLEANLINESS AND CONTAMINATION CONTROLS		1	2	3	4
	CLEAN IN ACCORDANCE WITH APPLICABLE DOCUMENTS					X X X X
	MAINTAIN CLEANLINESS LEVEL					X X X
	DOCUMENT METHODS AND PROCEDURES					X X X
1B6031	PROCESS CONTROLS		1	2	3	4
	TEST PROCESSING MATERIALS PERIODICALLY					X X
	TEST SAMPLE COUPONS FOR PHYSICAL PROPERTIES					X X
	TEST HARDWARE FOR PROCESS ACCEPTABILITY					X X
	IMPLEMENT CONTROLS FOR NON-INSPECTABLE PROCESSES					X X
1B6032	NDE SYSTEM		1	2	3	4
	USE NDE METHODS TO ENSURE QUALITY LEVELS					X X X
	PERSONNEL ARE ADEQUATELY TRAINED					X X
	PROCESSES HAVE BEEN CERTIFIED					X X
	FACILITIES & EQUIPMENT PROPERLY INSTALLED & MAINTAINED					X X
	MAINTAIN RECORDS OF NDT ACTIVITY					X X
	ADEQUATE COORDINATION WITH ENGINEERING					X X



DOCUMENT METHODS AND PROCEDURES		X X			
		1	2	3	4
1B6033	PROCESS CONTROL PROCEDURES				
	ASSURE PROCESS PROCEDURES SHALL INCLUDE OR REFERENCE:				
	PERFORMANCE AND CONTROL PROVISIONS	X	X	X	
	PREPARATION OF PROCESSING EQUIPMENT	X	X	X	
	PREPARATION OF MATERIALS	X	X	X	
	PROCESSING OPERATIONS CONDITIONS TO BE MAINTAINED	X	X	X	
	METHODS OF VERIFYING PROCESS PARAMETERS	X	X	X	
	DOCUMENTATION OF RESULTS	X	X	X	
	TEST AND INSPECTION PLANNING REQUIREMENTS	X	X	X	
	PROVIDE PROCEDURES ON REQUEST TO NASA		X	X	
	PROVIDE NECESSARY PROCEDURES TO SUBS		X	X	X
1B6034	EQUIPMENT CERTIFICATION	1	2	3	4
	CERTIFY EQUIPMENT FOR SELECTED PROCESSES	X	X	X	X
	MAINTAIN RECORDS OF CERTIFICATION	X	X	X	X
	RECERTIFY WHEN REQUIRED BY:				
	QA AUDIT	X	X	X	X
	INSPECTION OR TEST	X	X	X	X
	EQUIPMENT CHANGES	X	X	X	X
1B604	WORKMANSHIP STANDARDS	1	2	3	4
	WORKMANSHIP STANDARDS CONTRACTOR/NASA SELECTED	X			
	WORKMANSHIP STANDARDS CONTRACTOR SELECTED		X	X	
	WORKMANSHIP STANDARDS IN SPECS				X
1B6051	CONTROL OF TEMPORARY INSTALLATIONS	1	2	3	4
	DISTINCTIVELY IDENTIFY TEMPORARY ARTICLES		X	X	
	MAINTAIN RECORDS THRU LIFE OF END ITEM		X	X	
	MAINTAIN RECORDS THRU DELIVERY		X	X	
1B6052	MONITORING TEMPORARY INSTALLATIONS	1	2	3	4
	ASSURE NOT ASSEMBLED BY PERMANENT MEANS		X	X	
	ASSURE SECURE IDENTIFICATION		X	X	
1B6053	NONFUNCTIONAL TEMPORARY INSTALLATIONS	1	2	3	4
	ASSURE EQUIPMENT ADEQUATELY PROTECTED		X	X	
	CONTROL REMOVAL OF PROTECTIVE DEVICES		X	X	
	COLOR CODE AS NEEDED		X	X	
	IDENTIFY IN OTHER DOCUMENTS		X	X	
1B6054	NON-APPLICATION WORTHY COMPONENTS	1	2	3	4
	IDENTIFY AS NOT USABLE FOR INTENDED PURPOSE		X	X	
	ASSURE FUNCTIONAL TESTS NOT INVALIDATED		X	X	
1B6055	REMOVAL OF USABLE ARTICLES	1	2	3	4
	DOCUMENT ARTICLES REMOVED		X	X	
	PRECLUDE CONTAMINATION AND DAMAGE		X	X	



## INSPECTIONS AND TESTS

THE CONTRACTOR SHALL PLAN AND CONDUCT AN INSPECTION AND TEST PROGRAM WHICH DEMONSTRATES THAT CONTRACT, DRAWING, AND SPECIFICATION REQUIREMENTS ARE MET. THE PROGRAM AND ITS APPLICATION TO ALL PHASES OF THE CONTRACT SHALL PROVIDE ASSURANCE THAT THE QUALITY INHERENT IN THE DESIGN HAS BEEN ACHIEVED. SHUTTLE ORIENTED CHANGES HAVE BEEN ADDED IN THE QUALIFICATION TESTING, WALK-THRU/SHAKEDOWN INSPECTION AND TURNAROUND AND MAINTENANCE INSPECTION AREAS.

1B701	INSPECTION AND TEST PLANNING	A	1	2	3	4
	THE CONTRACTOR SHALL PROVIDE A PLANNING FUNCTION TO ACCOMPLISH:					
	ORDERLY AND TIMELY INSPECTION AND TESTING					X
	SEQUENCING OF INSPECTION & TESTING					X
	EFFECTIVE USE OF EQUIPMENT					X
	AVAILABILITY OF INSPECTION AND TEST EQUIPMENT					X
	COORDINATION OF NASA INSPECTIONS AND TESTS					X
	THE QUALITY ORGANIZATION SHALL ASSURE:					
	ORDERLY AND TIMELY INSPECTION					X X X
	SEQUENCING OF INSPECTION FOR MINIMUM TESTING					X X X
	AVAILABILITY OF INSPECTION EQUIPMENT					X X X
	COORDINATION OF NASA INSPECTIONS					X X X
	USE OF PRODUCT PROPERTIES PROGRAM					X X
	IDENTIFICATION OF SPECIAL CONTROLS AND EQUIPMENT					X X X
	ACCURACY OF PRODUCTION FIXTURES USED FOR INSPECTION					X X
1B702	TEST SPECIFICATIONS		1	2	3	4
	ASSURE TEST SPECIFICATIONS INCLUDE AS APPLICABLE:					
	TEST ITEM NOMENCLATURE AND IDENTIFICATION					X X X X
	TEST OBJECTIVES					X X X X
	QUANTITY TO BE TESTED					X X X X
	RELIABILITY GOAL					X
	TEST PARAMETERS AND TOLERANCES					X X X X
	ACCEPTANCE AND REJECTION CRITERIA					X X X X
	ENVIRONMENTAL CONDITIONS					X X X X
	HAZARDOUS SITUATIONS					X
	SAFETY STANDARDS					X
	ALLOWABLE ADJUSTMENTS					X X X X
	REPAIR, REWORK OR MAINTENANCE OPERATIONS					X X X X
	REQUIREMENTS FOR DATA RECORDING/ANALYSIS/RETEST					X X X X
	DISPOSITION OF TEST ARTICLE					X X X X
	NDE TESTING REQUIREMENTS					X X X
1B703	INSPECTION AND TEST PROCEDURES		1	2	3	4
	PROCEDURES SHALL INCLUDE AS APPLICABLE:					
	TEST ITEM NOMENCLATURE AND IDENTIFICATION					X X X X
	CHARACTERISTICS AND TOLERANCES TO BE INSPECTED					X X X X
	GOVERNMENT INSPECTION REQUIREMENTS					X X X X
	DETAILED INSPECTION SEQUENCE					X X X
	CHARACTERISTICS AND MEASURING EQUIPMENT TO BE USED					X X X X
	OPERATION OF AUTOMATED TEST EQUIPMENT					X X X X



TEST EQUIPMENT SETUP	X X X X
HAZARDOUS SITUATIONS	X X X X
ESTABLISHED SAFETY REQUIREMENTS	X X X X
ENVIRONMENTAL CONDITIONS TO BE MAINTAINED	X X X X
WORKMANSHIP STANDARDS	X X X X
CONSTRAINTS ON INSPECTION AND TESTING	X X X X
SPECIAL INSTRUCTIONS FOR NONCONFORMANCES	X X X X
SAMPLING PLANS TO BE USED	X X X
NDF REQUIREMENTS	X X X
1B704 END ITEM INSPECTION AND TEST SPECIFICATIONS AND PROCEDURES	1 2 3 4
PREPARE END-ITEM INSPECTION PROCEDURES	X X X
TESTS SHALL SIMULATE END-USE WITHOUT DAMAGE	X
ASSURE END-ITEM IS CAPABLE OF MEETING CONTRACT REQTS	X X X X
1B7051 INSPECTIONS AND TEST PERFORMANCE	1 2 3 4
INSPECTION AND TESTS SHALL BE:	
PERFORMED PRIOR TO INSTALLATION IN NEXT LEVEL	X X X
TRACEABLE TO THE INDIVIDUAL	X X X
CONTROL OF ARTICLES	
ARTICLES SHALL BE INSPECTED TO APPLICABLE DOCUMENTS	X X X X
ARTICLES SHALL NOT BE ADJUSTED EXCEPT AS SPECIFIED	X X X X
CONTROL OF INSPECTION AND TEST ENVIRONMENTS AND EQUIPMENT	
ENVIRONMENTS SHALL BE CONTROLLED	X X X X
EQUIPMENT SHALL BE MAINTAINED AND CALIBRATED	X X X X
REINSPECTION AND RETEST MAY BE REQUIRED WHENEVER:	
ARTICLE DOES NOT MEET CONTRACT REQUIREMENTS	X X X X
INSPECTION AND TEST NOT TO SPECIFICATION	X X X X
EQUIPMENT MALFUNCTION OCCURS	X X X X
ARTICLE MODIFIED AFTER START OF TEST	X X X X
ARTICLE SUBJECT TO DRIFT OR DEGRADATION	X X X X
SPECIFIED BY MATERIAL REVIEW BOARD	X X X X
1B7052 QUALIFICATION TEST ARTICLES	1 2 3 4
TEST ARTICLES SHALL BE CONTROLLED TO 1B7051 AND SHALL BE:	
RANDOMLY SELECTED AND REPRESENTATIVELY TESTED	X
UNIQUELY IDENTIFIED	X X
REPRESENTATIVE OF FLIGHT ARTICLE	X X
NOT USED FOR FLIGHT	X X
VERIFY FOLLOWING RECORDS AND PROCEDURES AVAILABLE:	
MANUFACTURING AND INSPECTION RECORDS	X X
END-ITEM INSPECTION AND TEST SPECIFICATIONS	X X
AUTHORIZED DEVIATIONS	X X
NONCONFORMANCES	X X
APPROVED WAIVERS	X X
REMOVAL AND INSTALLATION RECORDS	X X
OPERATING TIME RECORDS	X X
CHANGE VERIFICATION RECORDS	X X
SAFETY PROCEDURES	X X
EMERGENCY SHUTDOWN PROCEDURES	X X
REWORK AND RETEST CRITERIA	X X



PROCEDURES FOR SPECIAL MEASURING DEVICES		X	X
1B7053	REQUALIFICATION TESTING	1	2 3 4
	PROVIDE THE NASA WITH REQUALIFICATION DECISION DATA	X	
	SPECIFY NEED/EXTENT REQUALIFICATION NECESSARY	X	
	OBTAIN NASA APPROVAL PRIOR TO REQUALIFICATION TESTING	X	
	DEFINE WHEN REQUALIFICATION NECESSARY	X	X
1B7054	QUALIFICATION BASED ON SIMILARITY	1	2 3 4
	SIMILARITY BETWEEN ARTICLES MUST BE ESTABLISHED	X	
	TEST LEVELS AT LEAST AS STRINGENT AS QUALIFICATION	X	
	TEST DATA SHALL BE SUBMITTED TO THE NASA	X	
1B7055	END-ITEM INSPECTIONS AND TESTS	1	2 3 4
	PERFORM INSPECTIONS AND TESTS ON END-ITEM	X	X X X
	CLOSE OUT NONCONFORMANCES BEFORE TESTING	X	
	EVALUATE NONCONFORMANCES BEFORE TESTING		X X X
	NONCONFORMANCE DURING AND AFTER TESTING SHALL BE CLOSED	X	X X X
	INSPECTIONS AND TESTS SHALL BE IN ACCORDANCE WITH SPECS	X	X X X
	REPORT TO THE NASA ANY UNUSUAL PHENOMENA	X	X X
	STOP TESTING WHEN SAFETY OF PERSONNEL IN JEOPARDY	X	X X X
1B7056	END-ITEM REINSPECTION AND RETEST	1	2 3 4
	ADJUSTMENTS AFTER I&T REQUIRE NASA APPROVAL	X	X X
	CONTRACTOR SHALL RECOMMEND ADDITIONAL I&T	X	X X
	ADJUSTMENTS MUST HAVE APPROPRIATE PLANNING	X	X X
1B7057	END-ITEM INSPECTION AND TEST REPORT	1	2 3 4
	SUMMARY TEST REPORT FOR EACH END-ITEM SHALL INCLUDE:		
	END-ITEM IDENTIFICATION	X	X X
	IDENTIFICATION OF ARTICLES REMOVED OR REPLACED	X	X X
	COPIES OF APPROVED REQUESTS FOR NONCONFORMANCES	X	X X
	LIST OF AUTHORIZED TESTS OR RETESTS NOT COMPLETED	X	X X
	SUMMARY OF TEST DATA AND RESULTS	X	X X
	LIST OF CRITICAL AND LIMITED LIFE ARTICLES	X	X X
	OPERATING TIME/CYCLE RECORDS	X	X
1B7061	INSPECTION AND TEST RECORDS AND DATA	1	2 3 4
	MAINTAIN RECORDS AND DATA OF INSPECTIONS AND TESTS	X	X X X
1B7062	EQUIPMENT RECORDS	1	2 3 4
	MAINTAIN HISTORY OF EACH SYSTEM/SUBSYSTEM WHICH CONTAINS:		
	CONFIGURATION DATA	X	X X
	FABRICATION AND ASSEMBLY HISTORY	X	X X
	INSPECTION AND TEST RECORDS	X	X X
	NONCONFORMANCE SUMMARY	X	X X
	OPERATING TIME/CYCLE RECORDS	X	X X
	MAINTENANCE RECORDS	X	X X
	SUBSYSTEM RECORDS SHALL BE COMBINED INTO SYSTEM RECORDS	X	X X
1B7063	ACCEPTANCE DATA PACKAGE	1	2 3 4



	ASSURE ACCUMULATION OF ACCEPTANCE DATA PACKAGE	X	X		
	TABLE OF CONTENTS	X	X		
	WAIVERS AND DEVIATIONS	X	X		
	TIME/CYCLE LIST	X	X		
	AGE SENSITIVE COMPONENTS LIST	X	X		
	SHIPPING DOCUMENTS	X	X		
	OPEN WORK ITEMS	X	X		
	UNACCOMPLISHED TESTS	X	X		
	SHORTAGES	X	X		
1B7071	CONTRACTOR QUALITY ASSURANCE ACTIONS, PRIOR TO TESTING	1	2	3	4
	PRIOR TO TESTING QUALITY ASSURANCE PERSONNEL SHALL:				
	VERIFY INSPECTION AND TEST DOCUMENTS AVAILABLE	X	X	X	
	ENSURE SELECTION AND CONTROL OF ARTICLES	X	X	X	
	VERIFY THAT ARTICLES HAVE BEEN IDENTIFIED	X	X	X	
	VERIFY CONFIGURATION OF THE ARTICLES	X	X	X	
	VERIFY CONFIGURATION OF THE GSE				
	VERIFY THAT TEST EQUIPMENT IS CALIBRATED	X	X	X	
	VERIFY OPEN ITEMS AND CONSTRAINTS RESOLVED	X	X	X	
	VERIFY THAT FACILITY READY FOR TEST	X	X	X	
	VERIFY TEST PROCEDURES/SPECIFICATIONS APPROVED	X	X	X	
	APPROVE START OF TESTING	X	X	X	
1B7072	CONTRACTOR QUALITY ASSURANCE ACTIONS, DURING TESTING	1	2	3	4
	DURING TEST QUALITY ASSURANCE PERSONNEL SHALL:				
	ENSURE TESTING IN ACCORDANCE WITH SPECS AND PROCEDURES	X	X	X	
	ENSURE RECORDING OF DATA AND TEST RESULTS	X	X	X	
	DOCUMENT MODIFICATION DURING TEST OPERATION	X	X	X	
	DOCUMENT/PARTICIPATE IN NONCONFORMANCE DISPOSITION	X	X	X	
1B7073	CONTRACTOR QUALITY ASSURANCE ACTIONS, SUBSEQUENT TO TESTING	1	2	3	4
	SUBSEQUENT TO TEST QUALITY PERSONNEL SHALL:				
	ENSURE PROPER DISPOSITION OF ARTICLES	X	X	X	X
	DOCUMENT/PARTICIPATE IN NONCONFORMANCE DISPOSITION	X	X	X	X
	ENSURE REMEDIAL AND PREVENTATIVE ACTIONS TAKEN	X	X	X	
	VERIFY TEST RESULTS ACCURATE AND TRACEABLE	X	X	X	
1B708	WALK-THRU/SHAKEDOWN INSPECTIONS	1	2	3	4
	CONDUCT SCHEDULED WALK-THRU/SHAKEDOWN INSPECTIONS		X		
	ALLOW NASA PARTICIPATION IN THE INSPECTIONS		X		
	ISSUE A REPORT ON EACH INSPECTION		X		
	MAINTAIN REPORTS AVAILABLE FOR THE NASA REVIEW		X		
1B709	TURNAROUND AND MAINTENANCE INSPECTIONS	1	2	3	4
	QA SHALL TAKE PART IN MAINTENANCE INSPECTIONS		X	X	X
	THESE ACTIVITIES SHALL:				
	INCLUDE INSPECTION AND TEST PLANNING		X	X	
	ENSURE MAINTENANCE PROCEDURES PREPARED AND AVAILABLE		X	X	
	ENSURE COMPLIANCE WITH PROCEDURES AND SPECIFICATIONS		X	X	
	ENSURE RECORDS OF ALL INSPECTIONS AND TESTS		X	X	
	ENSURE ACCEPTANCE CRITERIA DEFINITIVE		X	X	



PERFORM WALK-THRU/SHAKEDOWN INSPECTIONS

X



## NONCONFORMING ARTICLE AND MATERIAL CONTROL

THE NONCONFORMANCE REPORTING SYSTEM FOR MATERIAL AND ARTICLE CONTROL WILL UTILIZE THE BASIC METHODS PRESENTLY EMPLOYED ON THE APOLLO CSM PROGRAM. THIS SYSTEM, SURNAMED THE "DISPOSITION RECORD" SYSTEM (DR/DRSS/CAR) PROVIDES THREE FUNDAMENTAL ADVANTAGES FOR THE SPACE SHUTTLE PROGRAM 1< AN ASSURANCE THAT POSITIVE CORRECTIVE ACTION IS EFFECTED 2< TRACEABILITY OF A NONCONFORMANCE FROM INITIATION OF DOCUMENTATION, ANY MR ACTION AND SUBSEQUENT PREVENTIVE ACTION BY ONE BASIC DOCUMENT NUMBER AND, 3< DIFFERENTIATION BETWEEN SIGNIFICANT NONCONFORMANCES AND THOSE WHICH ARE TRADITIONALLY LESS SIGNIFICANT FOR PURPOSES OF REMEDIAL AND PREVENTIVE ACTION.

1B800	NONCONFORMING (NC) ARTICLE AND MATERIAL CONTROL	1	2	3	4	
	IDENTIFY NONCONFORMING MATERIAL	X	X	X	X	
	SEGREGATE NONCONFORMING MATERIAL	X	X	X	X	
1B8011	NONCONFORMANCE DOCUMENTATION	1	2	3	4	5
	ESTABLISH A DOCUMENTATION SYSTEM TO:					
	RECORD NONCONFORMANCES	X	X	X	X	
	REPORT NONCONFORMANCES	X	X	X	X	
	ANALYZE NONCONFORMANCES	X	X	X	X	
	CORRECT NONCONFORMANCES	X	X	X	X	
	MAINTAIN RECORDS OF NONCONFORMANCES	X	X	X	X	
	MAINTAIN RECORDS OF MRB ACTIONS	X	X	X	X	
	PREPARE FAILURE AND NONCONFORMANCE SUMMARY REPORTS		X	X		
	ESTABLISH A SYSTEM FOR HANDLING MINOR NONCONFORMANCES		X	X	X	
1B8012	NONCONFORMANCE CONTROL SYSTEM					
	ESTABLISH MAJOR SITE PREVENTIVE ACTION CENTERS		X	X		
	ESTABLISH & IMPLEMENT A PROGRAM ACTION CENTER		X	X		
1B8013	POST-FLIGHT NONCONFORMANCE DOCUMENTATION	1	2	3	4	
	ESTABLISH AND IMPLEMENT A PREVENTIVE ACTION SYSTEM		X			
1B802	REMEDIAL AND PREVENTIVE ACTION	1	2	3	4	
	CONDUCT ANALYSIS AND EXAMINATION OF NC ARTICLES	X	X	X	X	
	IMPLEMENT TIMELY & EFFECTIVE REMEDIAL ACTION	X	X	X	X	
	IMPLEMENT TIMELY & EFFECTIVE PREVENTIVE ACTION	X	X	X		
	FOLLOW-UP TO ENSURE ACCOMPLISHMENT	X	X	X		
	NOTIFY CONTRACTOR/SUPPLIER ORGANIZATIONAL ELEMENTS	X	X	X		
	CLASSIFY NC'S FOR CRITICALITY	X	X			
	DOCUMENT ANALYSES, REMEDIAL AND PREVENTIVE ACTION	X	X	X		
	NOTIFY NASA OF NC'S AND ACTIONS TAKEN	X	X	X		
1B803	INITIAL REVIEW DISPOSITIONS	1	2	3	4	
	CONDUCT INITIAL REVIEW OF NC ARTICLES AND MATERIALS	X	X	X	X	
	OBTAIN SUPPLIER REMEDIAL AND PREVENTATIVE ACTION	X	X	X		
	MAINTAIN ACCOUNTING OF SCRAPPED ARTICLES	X	X			
1B804	MATERIAL REVIEW BOARD	1	2	3	4	



DEFINE MRB MEMBERSHIP & SCOPE OF APPLICABILITY	X	X	X	X
IMPLEMENT OPERATING BOARD CONCEPT		X	X	
ESTABLISH CRITERIA FOR FULL MRB RESPONS.		X	X	
OPERATING AND FULL MRB ARE RESPONSIBLE TO:				
DETERMINE OR RECOMMEND DISPOSITION	X	X	X	
DOCUMENT REMEDIAL ACTION PRIOR TO DISP.	X			
DOCUMENT REMEDIAL ACTION		X	X	X
VERIFY IMPLEMENTATION	X	X	X	X
RECOMMEND PREVENTIVE ACTION/ASSESSMENT		X	X	
AN OPERATING MRB CCMPRISED OF QA AND				
ENGINEERING PERSONNEL WILL BE ESTABLISHED				
TO DISPOSITION THOSE NONCONFORMANCES FOR				
WHICH CRITERIA HAS BEEN MUTUALLY ESTABLISHED.				
1B805 WRITTEN REQUESTS FOR NASA CONTRACTING OFFICIER APPROVAL	1	2	3	4
PREPARE REQUESTS FOR WAIVERS AND DEVIATIONS	X	X	X	
WITHHOLD ARTICLES/MTLS PENDING CUSTOMER APPROVAL	X	X	X	
1B806 SUPPLIER MATERIAL REVIEW BOARD	1	2	3	4
ESTABLISH SUPPLIER MRB RESPONSIBILITY	X	X	X	
OBTAIN NASA APPROVAL FOR DELEGATION	X	X	X	



## M E T R O L O G Y   C O N T R O L S

THE METROLOGY CONTROLS SECTION OF THE QUALITY CONTROL PLAN  
WILL DEFINE METHODS AND PROCEDURES THAT WILL ENSURE CONTROL  
OF SPACE SHUTTLE PROGRAM MEASUREMENT PROCESSES TO PROVIDE  
OBJECTIVE EVIDENCE OF QUALITY CONFORMANCE.

1B900	GENERAL	1	2	3	4
	PROVIDE A DOCUMENTED METROLOGY SYSTEM	X	X	X	X
	PROVIDE MEASUREMENT STANDARDS & EQUIP SELECTION CONTROL	X	X	X	X
	PERFORM MEASUREMENTS TO ESTABLISHED WRITTEN PROCEDURES	X	X	X	X
1B901	ACCEPTANCE	1	2	3	4
	ENSURE MEAS STANDARDS & EQUIPMENT CONFORM TO REQUIREMENTS	X	X	X	X
	DOCUMENT RESULTS AND MAINTAIN RECORDS	X	X	X	X
1B902	EVALUATION	1	2	3	4
	EVALUATE SPECIAL MEAS STDS & EQUIPMENT TO VERIFY				
	MEASUREMENT OF DESIRED CHARACTERISTICS AND ACCURACY	X	X	X	X
	PROVIDE DESIRED INDICATIONS & RECORDS	X	X	X	X
	ASSURE COMPATIBILITY WITH HARDWARE & ENVIRONMENT	X	X	X	X
	PROVIDE OPERATING INSTRUCTIONS	X	X	X	X
	DOCUMENT RESULTS OF EVALUATION	X	X	X	X
1B903	ARTICLE OR MATERIAL MEASUREMENT PROCESSES	1	2	3	4
	ASSURE 10:1 RATIO OF ACCURACY	X	X	X	X
	OBTAIN AUTHORIZATION FOR EXCEPTIONS	X	X	X	X
1B904	CALIBRATION MEASUREMENT PROCESSES	1	2	3	4
	ASSURE 4:1 RATIO OF ACCURACY	X	X	X	X
	OBTAIN AUTHORIZATION FOR EXCEPTIONS	X	X	X	X
1B905	CALIBRATION CONTROLS	1	2	3	4
	PROVIDE FACILITY FOR CALIBRATION OF STDS & EQUIPMENT	X	X	X	X
	ASSURE TRACEABILITY TO NBS	X	X	X	X
	PROVIDE HANDLING, STORAGE & TRANSPORTATION CONTROLS	X	X	X	X
	IDENTIFICATION AND LABELLING:				
	WILL DISPLAY CALIBRATION STATUS AND DUE DATES	X	X	X	X
	WILL BE TAMPER PROOF		X	X	X
	OPERATE A CALIBRATION INTERVAL ADJUSTMENT PROGRAM	X	X	X	X
	PROVIDE A CALIBRATION RECALL SYSTEM	X	X	X	X
	IDENTIFICATION OF ITEM CALIBRATED	X	X	X	X
	CALIBRATION RECORDS SHALL INCLUDE:				
	IDENTIFICATION OF STD AND PROCEDURE	X	X	X	X
	CALIBRATION INTERVAL LENGTH	X	X	X	X
	DATE & RESULTS OF CALIBRATION	X	X	X	X
	NEXT CALIBRATION DUE DATE	X	X	X	X
	INDIVIDUAL(S) PERFORMING CALIBRATION	X	X	X	X
	CALIBRATION FACILITY IDENTIFICATION	X	X	X	X
	NONCONFORMANCE AS RECEIVED	X	X	X	X



HISTORICAL RECORD OF CALIBRATIONS, REPAIRS & MAINTENANCE		X	X	X	
1B906	ENVIRONMENTAL REQUIREMENTS	1	2	3	4
	PROVIDE ENVIRONMENT COMPATIBLE WITH MEAS & CALIB REQMTS	X	X	X	X
1B907	REMEDIAL AND PREVENTIVE ACTION	1	2	3	4
	INITIATE CALIBRATION NONCONFORMANCE REPORT	X	X	X	
	PROVIDE FOLLOW-UP AND PRODUCT DISPOSITION	X	X	X	
	PROVIDE PREVENTIVE ACTION TO PRECLUDE RECURRENCE	X	X	X	
	TAG NONCONFORMING EQUIP TO PREVENT USAGE		X	X	X



## S T A M P   C O N T R O L S

A STAMP CONTROL PROGRAM SHALL BE ESTABLISHED AND MAINTAINED WHICH WILL INDICATE THAT A PART, ASSEMBLY OR ITEM PHYSICALLY AND FUNCTIONALLY DOES OR DOES NOT COMPLY WITH THE APPLICABLE SPECIFICATIONS, DRAWINGS OR OTHER DOCUMENTATION SPECIFYING PART CONFIGURATION, PERFORMANCE AND QUALITY.

1B1000	STAMP CONTROL SYSTEM	1	2	3	4
	ESTABLISH AND MAINTAIN A DOCUMENTED STAMP CONTROL SYSTEM	X	X	X	X
	THE SYSTEM SHALL PROVIDE FOR THE FOLLOWING:				
	IDENTIFICATION OF INSPECTED AND TESTED ARTICLES	X	X	X	X
	STAMPS SHALL BE TRACEABLE TO THE INDIVIDUAL	X	X	X	X
	FAB AND INSPECTION STAMPS SHALL BE DIFFERENT	X	X	X	X
	STAMPS SHALL BE APPLIED TO RECORDS TO INDICATE STATUS	X	X	X	X
	STAMPS SHALL BE APPLIED TO ATTACHMENTS AS APPROPRIATE	X	X	X	X
	STAMPS MAY BE APPLIED DIRECTLY TO ARTICLES	X	X	X	X
	STAMPING METHODS MUST BE COMPATIBLE WITH ARTICLES	X	X	X	X
	REISSUE AND REPLACEMENT OF STAMPS				
	UNIQUE IDENTIFICATION MARKS FOR DIFFERENT OPERATIONS	X	X	X	
	PUBLISH A QUARTERLY LIST OF CURRENT STAMPS	X	X	X	
	VERIFICATION OF STAMP LEGIBILITY	X	X	X	
1B1001	STAMP RESTRICTION	1	2	3	4
	STAMPS SHALL NOT CONTAIN THE DESIGNATION 'NASA'	X	X	X	X



HANDLING STORAGE PRESERVATION MARKING LABELLING PACKAGING PACKING SHIPPING

THE QUALITY ASSURANCE FUNCTION SHALL ASSURE THAT PRODUCT HAS BEEN CLEANED, PRESERVED, PACKAGED AND MARKED IN ACCORDANCE WITH REQUIREMENTS; VERIFY THAT DOCUMENTATION FOR DELIVERY IS IN ACCORDANCE WITH SHIPPING INSTRUCTIONS; AND VERIFY THAT HANDLED AND STORED SO AS TO PROTECT AGAINST DETERIORATION AND DAMAGE.

2B11001 HANDLING	1 2 3 4
ARTICLES SHALL BE PROTECTED DURING ALL PHASES	X X X X
SPECIAL HANDLING INSTRUCTIONS SHALL BE DISTRIBUTED	X X X X
HANDLING EQUIPMENT SHALL BE PROOF TESTED	X X X X
1B11002 STORAGE	1 2 3 4
ARTICLES TO BE STORED SHALL BE PROTECTED	X X X X
AGE DETERIORATION DATA SHALL BE INCLUDED ON CONTAINER	X X X X
ENSURE THE FOLLOWING:	
SAFETY OF PERSONNEL	X X X X
MAINTAINANCE	X X X X
POSITIVE IDENTIFICATION	X X X X
PERIODIC INSPECTION	X X X X
PERIODIC TEST	X X X X
MAINTAINED CLEANLINESS	X X X
1B11011 PRESERVATION	1 2 3 4
ARTICLES SHALL BE CLEANED AND PRESERVED	X X X X
1B11012 MARKING AND LABELLING	1 2 3 4
ENSURE MARKING AND LABELLING PER REQUIREMENTS	X X X X
CRITICAL ARTICLES SHALL HAVE SPECIAL ATTENTION	X X X
ASSURE SPECIAL LABELLING OF CLEANED ARTICLES	X X X
1B11013 PACKAGING	1 2 3 4
ARTICLES SHALL BE PACKAGED TO PREVENT DETERIORATION	X X X X
PACKAGING RQMTS APPLY TO SOURCE, MOVE AND DESTINATION	X X X X
ENVIRONMENTAL RQMTS SHALL BE INCLUDED	X X X X
ASSURE DESIGN OF SPECIAL PACKAGING AS REQUIRED	X X X X
PROVIDE SUITABLE PACKING TO PREVENT PHYSICAL DAMAGE	X X X X
TESTS OF PACKING SHALL BE PERFORMED AS NECESSARY	X X X X
1B11014 PACKING	1 2 3 4
ASSURE SUITABLE PACKAGING TO PREVENT PHYSICAL DAMAGE	X X X X
TESTS OF PACKING SHALL BE PERFORMED AS NECESSARY	X X X X
1B11021 SHIPPING CONTROL	1 2 3 4
THE CONTRACTOR SHALL ENSURE THAT:	
INSPECTION AND TESTING REQUIRED HAS BEEN COMPLETED	X X X X
DOCUMENTS HAVE BEEN IDENTIFIED TO INSPECTION STATUS	X X X X
PRESERVATION AND PACKAGING PER RQMTS	X X X X
IDENTIFICATION AND MARKING PER SPECIFICATIONS	X X X X



ICC REGULATION FOR PACKING AND MARKING AS MINIMUM	X	X	X	X
HANDLING DEVICES ARE SUITABLE TO PREVENT DAMAGE	X	X	X	X
LOADING AND TRANSPORT METHODS PER RQMTS	X	X	X	X
UNSCHEDULED REMOVAL REQUIRES NASA AUTHORIZED REINSPECTION	X	X	X	X
1B11022 DOCUMENTATION PACKAGE	1	2	3	4
DOCUMENTATION PACKAGE SHALL BE INCLUDED WITH SHIPMENT	X	X	X	X
CONTENTS SHALL BE DOCUMENTS SPECIFIED BY CONTRACT	X	X	X	X
SHIPPING CONTAINER SHALL IDENTIFY PACKAGE LOCATION	X	X	X	X
SAMPLING PLANS, STATISTICAL PLANNING AND ANALYSIS				
1B1200 SAMPLING PLANS	1	2	3	4
SAMPLING PLANS MAY BE USED AS APLICABLE	X	X	X	X
EXISTING MILITARY SAMPLING SPECS WILL BE UTILIZED	X	X	X	X
NON-STD SAMPLING PLANS MAY BE UTILIZED	X	X	X	X
NON-STD SAMPLING PLANS REQUIRE NASA APPROVAL PER DRD	X	X	X	X
1B1201 STATISTICAL PLANNING AND ANALYSIS	1	2	3	4
STATISTICAL METHODS MAY BE USED AS APPLICABLE	X	X	X	X



G O V E R N M E N T P R O P E R T Y C O N T R O L

1B1300	CONTRACTOR'S RESPONSIBILITY		1	2	3	4
	THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL GOVT PROPERTY	X				
	THE QA ORGANIZATION SHALL BE RESPONSIBLE TO:					
	EXAMINE TO DETECT TRANSIT DAMAGE		X	X	X	
	VERIFY CONTENTS PER SHIPPING DOCUMENTS		X	X	X	
	ASSURE PROTECTION AGAINST DAMAGE & DETERIORATION		X	X	X	
	ASSURE MAINTENANCE OF FOLLOWING RECORDS:					
	IDENTIFICATION OF PROPERTY		X	X	X	
	RESULTS OF INSPECTIONS		X	X	X	
	FUNCTIONAL TEST PER CONTRACT REQTS PRIOR TO USE		X	X	X	
1B1301	UNSUITABLE GOVERNMENT PROPERTY		1	2	3	4
	THE CONTRACTOR SHALL REPORT UNSUITABLE GOVT PROPERTY	X				
	QA SHALL ASSURE REPORTING OF UNSUITABLE GOVT PROPERTY		X	X	X	

END OF DOCUMENT  
(ATS/360 41005010003:6)



SYSTEM SAFETY REQUIREMENTS  
FOR  
SPACE SHUTTLE

PROGRAM MANAGEMENT PLAN

APPENDIX F

(ATS/360 41005010006:6)

SPACE DIVISION  
NORTH AMERICAN ROCKWELL



APPENDIX F  
To Space Shuttle Program Management Plan  
System Safety Requirements

The Matrix Gives Safety Tasks/Requirements For Program Phases C/D To Provide For Identification And Elimination Of Hazards Or Implementation Of Recommended Preventive/Protective Resolutions.

The Terms Used and Definitions Which Differ From SPD-1A Are Given In The Safety Requirements Document Dictionary, Ref. Appendix F-1.

Right Hand Columns Of The Matrix Are Designated As Follows

- A SAFETY PROGRAM DIRECTIVE NO.1-REV A (SPD-1A)
- B SYSTEM SAFETY PLAN
- C FLIGHT VEHICLE
- D MISSION ESSENTIAL GSE
- E NON-MISSION ESSENTIAL GSE
- F LAUNCH FACILITY
- G RECOVERY SITES
- H GROUND OPERATIONS (FROM TOUCHDOWN TO NEXT FLIGHT)
- I MFG AND TEST FACILITY
- J MFG OPERATIONS
- K GROUND TESTS
- L FLIGHT TESTS
- M OPERATIONAL FLIGHTS

		AB	C	D	E	F	G	H	I	J	K	L	M
4.1	SYSTEM SAFETY PLAN												
	A SUBMIT PRELIMINARY PLAN WITH PROPOSAL												X
	F SUBMIT FINAL PLAN AS CONTRACTUAL DOCUMENT												XX
4.1.1	DEFINE ORGANIZATIONAL STRUCTURE												XX
4.1.2	DEVELOP/IMPLEMENT MGMT AND CONTROL PROCED												XX
4.1.3	DEFINE PROGRAM REVIEW/PROG REPTG REQMTS												XX
4.1.4	DEFINE SUBCONTRACTORS SYST SAFETY REQMTS												X
4.2	HAZARD ANALYSES (HA)												
4.2.1	CONDUCT PRELIMINARY GROSS HA	XX	X	X	X	X	X	X	X	X	X	X	X
4.2.2	CONDUCT DETAILED HA												
	A SYSTEM HA	XX	X	X	X								
	B SUBSYSTEM HA	XX	X	X	X								
	C EQUIPMENT HA	XX	X	X	X								
	D ISSUE SAFETY ANALYSIS REPORT (SAR) (REF ITEMS 5.6 B AND C)	X											
		AB	C	D	E	F	G	H	I	J	K	L	M
4.2.3	CONDUCT OPERATING HA												
	A INSTALLATION ANALYSIS	XX	X	X	X	X			X	X	X	X	X
	B MAINTENANCE ANALYSIS	XX	X	X					X				
	C SUPPORT ANALYSIS	XX	X	X					X			X	X
	D TESTING ANALYSIS	XX	X	X	X	X			X		X	X	
	E OPERATIONS ANALYSIS	XX	X	X		X	X	X			X	X	
	F EMERGENCY ESCAPE ANALYSIS	XX	X			X		X			X	X	
	G EGRESS ANALYSIS	XX	X			X					X	X	
	H RESCUE ANALYSIS	XX	X			X	X				X	X	
	I TRAINING SAFETY ANALYSIS	XX											
		AB	C	D	E	F	G	H	I	J	K	L	M
4.2.4	USE MSC-00134 AS A GUIDE	X											

[illegible]



4.12	ASSURE THAT SAFETY OF GFE IS CONSISTANT WITH OVERALL SYSTEM SAFETY REQUIREMENT	X	X	X	X	X							X	X
		AB	C	D	E	F	G	H	I	J	K	L	M	
5.0	SYST SAFETY IMPLEMENTATION ASSURANCE													
A	UTILIZE A SAFETY CRITERIA CHECKLIST	X												
B	PROVIDE A HAZARD TRACKING SYSTEM	X												
5.1	SAFETY TEST ASSURANCE													
A	ASSURE CONDUCT OF APPLIC MARGIN OF SAFETY TESTS	XX												
B	ASSURE CONDUCT OF APPLIC INDUCED FAILURE TESTS	XX												
C	SAFETY PARTICIPATE IN REVIEW OF TEST PLANS	X												
D	SAFETY PARTICIPATE IN SELECTING ITEMS TO TEST	X												
5.2	SAFETY OBSERVE HAZ & DANGEROUS OPERATIONS													
A	SPOT CHECK	XX			X			X	X	X	X			
B	FULL TIME MONITORING OF SELECTED OPERATIONS	XX	X	X		X							X	X
5.3	CONDUCT SAFETY AUDITS													
A	CONTRACTOR SAFETY AUDIT OWN SAFETY PROGRAM	XX												
B	CONTRACTOR SAFETY AUDIT SUBCONTRACTOR SAF PROGRAM	XX												
C	CONTRACTOR SUPPORT MSC SAFETY AUDIT OF CONTRACTOR'S SAFETY PROGRAM	XX												
		AB	C	D	E	F	G	H	I	J	K	L	M	
5.4	A PERFORM ANALYSES OF PROPOSED SAFETY SIGNIFICANT CHANGES IN DESIGNS, PROCEDURES AND OPERATIONS	XX												
B	ASSURE RESOLUTION OF HAZARDS IDENTIFD WITH CHANGES	XX												
C	PROVIDE IDENTIFIED CHANGE HAZARDS TO THE CCB	XX												
5.5	PARTICIPATE IN POST FLIGHT REVIEWS AND CONDUCT SAFETY EVALUATION CF ANOMALIES													
A	PROCEDURES AND PROTECTIVE EQUIPMENT	XX	X											X
B	WARNING DIVICES AND EMERGENCY EQUIPMENT	XX	X											X
C	CRITICAL FLIGHT EQUIPMENT OR SUBSYSTEMS	X												X
D	UNPREDICTED EVENTS	XX	X											X
5.5D	ASSESS EFFECTS OF HUMAN CAPABILITIES AND CONSTRAINTS ON CREW SAFETY FOR ANOMALOUS CONDITIONS	XX	X											X
5.5E	PROVIDE FOR PERTINENT INPUTS TO SAFETY DATA FILE	XX												
5.5F	ASSURE THAT ACTION IS TAKEN TO RESOLVE IDENTIFIED SAFETY CRITICAL ANOMALIES	X												
5.5G	PARTICIPATE IN MSC SAFETY PROGRESS MEETINGS	X												
5.6	SUPMIT THE FOLLOWING DATA IN ACCORDANCE WITH DRL													
	DOCUMENT													
	PARA TYPE DOC													
A	SYSTEM SAFETY PLAN	4.1	APPROVAL	XX										
B	HAZARD ANALYSIS REPORTS	4.2.1	REVIEW	XX										
C	PROGRAM MILESTONE REPORT	4.1.3	(BRIEF CHTS)	X										
D	NOTIFICATION, ACCIDENT/ INCIDENT	4.10	REVIEW	XX										
		AB	C	D	E	F	G	H	I	J	K	L	M	



DICTIONARY, SAFETY REQUIREMENTS DOCUMENT  
(APPENDIX F TO SPACE SHUTTLE PROGRAM MANAGEMENT PLAN)

This dictionary contains descriptions of tasks which differ from or are not included in Safety Program Directive No. 1 - Revision A.

SAFETY TERMS

The following terms used in this document are defined:

- a. Safety - Freedom from chance of injury or loss to personnel, equipment or property.
- b. System Safety - The reduction of the level of risk by management within the constraints of operational effectiveness, time, and cost attained through the application of management and engineering principles throughout all phases of a program from design concept through test and operations and through post flight analysis.
- c. Accident Prevention - Methods and procedures used to eliminate the causes which lead, or could lead, to an accident.
- d. Hazard - The presence of a potential risk situation caused by an unsafe act or condition, such that environment or natural phenomenon, personnel error, design characteristics, limited time for corrective action, procedure deficiencies, or subsystem malfunction which will cause system or personnel loss.
- e. Risk - The chance (qualitative) of injury to personnel or loss of equipment, or property.
- f. Hazard Analysis - The determination of potential sources of danger and recommended resolutions in a timely manner for those conditions found in either the hardware/software systems, the man-machine relationship, or both, which could cause an undesired event such as loss of crew or loss of the system. The process of identification of hazards is not limited to any one technique; supporting data for the hazard analyses may be derived from parametric studies, logic and flow diagram analyses, including fault tree analyses, ground and flight testing, failure mode and effects analyses, engineering analyses, simulations, malfunction and emergency procedures analyses, either individually or in combination. (Note: Identified failure modes, irrespective of subsystem or component redundancy, must be explained and tracked if judged to be a critical or catastrophic hazard).
- g. Personnel Loss - Loss function and inability to perform nominal and/or emergency operations.



- h. Fail Operational - The capability of a system, subsystem or component to fail without adversely affecting mission completion.
- i. Fail Safe - The capability of the system or subsystem to fail without being dangerous to equipment or personnel and of a functional back-up mode for personnel survival.
- j. Hazard Levels
  - 1. Catastrophic - Potential system loss or personnel function loss. Time and means are not available for corrective action.
  - 2. Critical - Potential system loss or personnel function loss counteracted by urgent automatic/manual action. Time is a significant factor for corrective action.
  - 3. Controlled - Potential system loss or personnel function loss counteracted and:
    - (a) Eliminated by appropriate design.
    - (b) Controlled by safety devices, including escape and rescue capability; alarms/caution and warning; automatic/manual action; procedures. Time is not a significant factor for corrective action.



The below listed items refer to specific paragraphs of Appendix F that differ from the criteria defined in SPD 1-A.

- 4.1 The Preliminary System Safety Plan defines the contractor's total safety program and is submitted with the proposal. After contract negotiations, the plan will be updated and resubmitted to NASA for incorporation into the contract.
  - 4.1.4 The contractor will define the subcontractor's system safety general requirements. Subsystems or test which the contractor considers safety critical will be identified and additional safety requirements imposed.
  - 4.2.4 The contractor will use MSC-00134, Space Flight Hazards Catalog, as a guide to reduction of hazards in equipment, procedures and facilities.
  - 4.2.5 The contractor will include safety in trade studies by utilization of safety and safe design and operations criteria and by conducting hazard analyses in safety critical areas.
  - 4.2.6 The contractor's system safety organization will prepare and update safety criteria.
- 4.6 G Safety test requirements shall be considered (and included where appropriate) in tests conducted to satisfy Engineering, Quality, Reliability, or other contract requirements.
- 4.6 H Hazard analyses, including descriptions of hazards and recommended or actual means of resolution, will be provided by the contractor to other contractor functions and to subcontractors as required to obtain maximum benefit and minimum duplication of safety analysis effort.
- 4.9. B C The contractor's System and Industrial Safety functions will review safety data supplied by NASA such as accident/incident records, alerts, criteria and standards and technical information bulletins (TIB's). Those applicable to Space Shuttle safety will be appropriately distributed to contractor or subcontractor functions for consideration.
- 4.11 The contractor's System functions will review manufacturing, test and operations procedures which have potential safety impact. Those which are considered safety critical will be so identified and appropriate safety requirements added.
- 4.12 The contractor's safety organization will obtain from NASA all applicable documents available concerning GFE to aid in assessing the safety of the article for Space Shuttle use.



- 5.0 A The contractor shall incorporate a system of tracking and identifying hazards to equipment and operations.
- 5.1 B,C The contractor's system safety program will provide for a safety review of test plans and lists of equipment to be tested to assure that equipment tests include safety requirements and that safety critical equipment is scheduled for test.
- 5.5 C The contractor's safety program shall provide for participation in post flight reviews and evaluation of anomalies occurring in critical flight equipment or subsystems.
- 5.5 F The contractor's safety program will provide a means to assure that action is taken to resolve anomalous conditions affecting equipment or personnel safety.
- 5.5 G The contractor's system safety program will include for system safety participation in NASA progress meetings to review anomalous conditions and the remedial action taken.

END OF DOCUMENT  
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## APPENDIX G

### DEVELOPMENT APPROACH

Cost effectiveness was a prime consideration in formulating the criteria for management systems and related management activities. Each requirement was considered in the light of current and recent experience to ensure that it calls for the fulfillment of a real management need and to ensure that it is economically achievable. Presented here are examples of results of this type of study process.

#### PROGRAM PLANS

Program plans will be required to provide an organized approach for implementation of basic program functions such as engineering, quality assurance, reliability, test, and system safety. Review of Apollo and related programs indicated that preparation and maintenance of plans consumed a significant number of man-hours. In large part this was because it was necessary to update the plans to reflect current internal documentation and procedures that govern the every day implementation of program functions. As a result of this analysis, the primary criteria for program plans requirements selected for the Space Shuttle Program are:

1. The number of program plans prepared shall be the minimum required for planning of the Space Shuttle Program.
2. Program plans shall be prepared as top-level planning documents.
3. Contractor's internal procedures shall be used to implement the program, and changes to these procedures will not be regulated by the contract.
4. Changes to program plans shall be made only when there is a need to change essential methods of the contractor.
5. The requirements and processes defined in the Phase B program plans shall be the baseline for development of Phase C and D program plans and contractor internal documentation.



## COST/SCHEDULE PLANNING AND CONTROL SYSTEMS

Cost/schedule planning and control requirements were selected after a thorough cost effectiveness analysis by the Phase B contractors. Requirements were developed from two approaches: (1) starting from the successful Apollo and Atlas programs of the 1960's and introducing practical modifications and (2) starting from concepts in NASA Coordination Draft, NHB 9501.2, Procedures for Reporting Correlated Cost and Performance Information from Contractors, dated July 20, 1970; Cost/Schedule Control Systems Criteria, AMCP 37-5, NAVMAT P5240, AFSCP 173-3, Joint Implementation Procedures, dated August 26, 1970; and Draft DOD 7000.2 Handbook, Guide for Performance Measurement Requirements of the Cost/Schedule Control Systems Criteria, dated August 1970, and tailoring these to cost/schedule planning and control criteria for the shuttle program. The requirements in this plan represent a consolidation of the best features of the two approaches.

### PLANNING LEVELS

Establishment of funds available for major space programs on a government-fiscal-year basis introduces the advisability of recognizing the need to realign program planning to accommodate any consequent rephasing of planned expenditures. Detail planning should therefore be firmed up for a period encompassing the current fiscal year. For continuity, and to assist in defining the following fiscal year requirements, detail planning should be extended beyond the current fiscal year as the end of that year is approached. Planning for subsequent periods should be maintained only at the highest WBS level (i. e., the program level), thereby reducing the quantity of detailed replanning to a minimum.

### ADVANCE PROBLEM WARNING

Previous management systems have provided functional managers with data on task or milestone completions versus schedule and actual expenditures versus plan. This indicated program status or the existence of problems. Establishment of WBS element task managers monitoring performance of costs and schedules against products provides an additional effective means for measuring work against products. Proper data analysis by these WBS element task managers will provide early indications of developing problems and hence facilitate formulation and application of preventive actions before larger cost and schedule impacts accrue.



For further anticipation of problems, one of the program requirements calls for formalizing the planning and tracking of hardware performance achievement during space shuttle design and development. Performance assessment has always been conducted within the engineering department, but with varying degrees of formalization.

Formalizing the tracking of performance achievement to include the scheduling of performance assessment points, the planning of expected values at those points, and reporting of actual assessment results to program management provides greater assurance that potential technical problems will be identified early enough to avoid serious delays or costly impacts to the program.

Implementation of this simplified technical performance management concept will add minimal cost to the system engineering effort.

#### DATA MANAGEMENT

Establishing data management requirements for the Space Shuttle Program involved conducting analyses to achieve the following results:

1. Determine the minimum data required to meet program management and technical requirements.
2. Provide the contractor sufficient latitude in the selection of data to allow full use of internal documentation and established processes and systems.
3. Ensure that only essential data are prepared as contract data and that maximum use is made of contractor internal data to satisfy contract data requirements.

Analysis of historical data systems and processes revealed expensive redundancy in the preparation and reformatting of data for individual function and organizational purposes. To reduce this redundancy and to meet the above objectives, the following requirements were selected for application on the Space Shuttle Program:

1. The contractor shall identify for the NASA specific data requirements for the program.



2. It was determined that the system by which the contractor plans, manages, and produces contractually deliverable data shall be similar to that by which hardware is planned, managed, and produced.
3. Contract data shall, to the maximum extent, be the same data in the same form and format as that which the contractor generates to satisfy his own internal requirements.

## CONFIGURATION MANAGEMENT

The approach to configuration management was to pattern requirements after principles demonstrated and proved on other programs. Cost effectiveness, in addition to the tailoring process, was emphasized in establishing the complete approach. For example, the approach taken on configuration accounting was to provide concise exception data through an integrated system that identifies differences between design requirements and the as-built configuration. The system will continually report the constraining requirements (design changes or shortages) pending to complete an authorized configuration item. Users, by this approach, will be provided the data needed as continuous exception reports. Complete status, such as configuration item baseline of part numbers, will be furnished to support program milestones (PDR, CDR, etc.). On past programs, in comparison, the approach has been to provide configuration accounting through a series of systems, each limited to a particular operations or hardware element such as production, test, operations, vehicle, etc.

The approach taken for the Space Shuttle Program provides a unified system that combines the requirements of internal functional organizations through a single program data bank.

## QUALITY ASSURANCE MANAGEMENT

The approach taken to establish quality assurance requirements involved analysis of NHB 5300.4 B requirements and their applicability to the Space Shuttle Program from the viewpoint of meeting program requirements at reduced costs. Emphasis was placed on those quality assurance functions that were identified as potential major cost areas. For example, establishment of an integrated quality information system was identified as a requirement for the Space Shuttle Program. The major criteria for such a system to be used on the Space Shuttle Program are:

1. Cut off quality information at the highest practical level (subsystem level where applicable).



2. Minimize repetitious quality assurance inputs.
3. Reduce the number and size of product reports and use exception reports.